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Record of Decision:

MCCLELLAN AIR FORCE BASE (GROUND WATER CONTAMINATION)
EPA ID: CA4570024337
OU 01
MCCLELLAN AFB, CA
05/11/1995

Final

Basewide Groundwater Operable Unit
Interim Record of Decision

Prepared for

McClellan Air Force Base
Contract No. F04699-90-D-0035
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Glossary of Terms

AFB	Air Force Base
AFGE	American Federation of Government Employees
aquifer	portion of subsurface below the water table
ARARs	applicable or relevant and appropriate requirements
AS	air stripper
ATSDR	Agency for Toxic Substances and Disease Registry
BACT	Best Available Control Technology
bgs	below ground surface
BW	Base Well
Cal-EPA/DTSC	California Environmental Protection Agency\Department of Toxic Substances Control
CARB	California Air Resources Board
CatOx	catalytic oxidation
CCR	California Code of Regulations
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
COCs	contaminants of concern
CRP	Community Relations Plan
CS	confirmed site
CWA	Clean Water Act
DCA	dichloroethane
DCE	dichloroethene
DHS/ODW	California Department of Health Services/Office of Drinking Water
DNAPLs	dense nonaqueous phase liquids
DOD	Department of Defense
ECRSC	Environmental Community Relations Steering Committee
EE/CA	Engineering Evaluation/Cost Analysis
EPA	U.S. Environmental Protection Agency
FS	Feasibility Study
gpm	gallons per minute
GSAP	Groundwater Sampling and Analysis Program
GWTP	Groundwater Treatment Plant
HCI	hydrochloric acid
hot spot	area with groundwater VOC contamination greater than 500 micrograms per liter
IAG	Interagency Agreement
IRM	interim remedial measure
IRP	Installation Restoration Program
IWL	Industrial Wastewater Line
IWTP	Industrial Wastewater Treatment Plant
LGAC	liquid-phase granular activated carbon
LNAPLs	light nonaqueous phase liquids
MAP	Management Action Plan
MCLs	maximum contaminant levels as defined by the Safe Drinking Water Act
msl	mean sea level
NAPL	nonaqueous phase liquids
NCP	National Contingency Plan
NOAA	National Oceanic and Atmospheric Administration
NPL	National Priorities List
NOx	nitrogen oxides
O&M	operations and maintenance
OU	operable unit
PCBs	polychlorinated biphenyls
PCE	tetrachloroethene
PGOURI	Preliminary Groundwater Operable Unit Remedial Investigation
ppb	parts per billion
ppbv	parts per billion by volume
PRL	potential release location
RAB	Restoration Advisory Board
RCRA	Resource Conservation and Recovery Act of 1976
RD/RA	remedial design/remedial action
RI/FS	Remedial Investigation/Feasibility Study
RME	reasonable maximum exposure

ROD	Record of Decision
ROG	reactive organic gases
RPM	Remedial Project Manager
RWQCB	Regional Water Quality Control Board
SARA	Superfund Amendments and Reauthorization Act of 1986
SDWA	Safe Drinking Water Act
SMAQMD	Sacramento Metropolitan Air Quality Management District
SVAB	Sacramento Valley Air Basin
SVE	soil vapor extraction
T-BACT	Best Available Control Technology - Toxics
TBCs	to-be-considered criteria
TCE	trichloroethene
TRC	Technical Review Committee
USTs	underground storage tanks
vadose zone	soils above the groundwater
VGAC	vapor-phase granular activated carbon
VOCs	volatile organic compounds

Part 1: Declaration

A. Site Name and Location

Department of the Air Force
Sacramento Air Logistics Center
McClellan Air Force Base
Sacramento, California 95652
EPA ID# CA4570024337

B. Statement of Basis and Purpose

This Interim Record of Decision (Interim ROD) presents the interim remedial action for the Groundwater Operable Unit (Groundwater OU) at the McClellan Air Force Base (McClellan AFB) Superfund site in Sacramento, California. This interim remedial action was selected in accordance with the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), 42 USC § 9601 et seq., and with the National Oil and Hazardous Substances Pollution Contingency Plan, 40 CFR Part 300 (National Contingency Plan [NCP]). The Administrative Record identifies the documents upon which the selection of the remedial action is based. Part II, Section C, discusses the Administrative Record and where it can be examined.

The U.S. Environmental Protection Agency (EPA), Region IX, concurs with the selected remedy.

The State of California, through the California Environmental Protection Agency's Department of Toxic Substances Control (Cal-EPA/DTSC) and the Regional Water Quality Control Board (RWQCB), concurs with the selected remedy.

Releases of volatile organic compounds (VOCs) as a result of historic Base activities have contaminated the groundwater at McClellan AFB. Actual or threatened releases of hazardous substances from this site, if not addressed by implementing the response actions selected in this Interim ROD, may present an imminent and substantial endangerment to public health, welfare, or the environment.

C. Description of the Selected Remedy

C.1 Role of the Groundwater Operable Unit within the Overall Site Strategy

The Groundwater OU addresses all of the VOC-contaminated groundwater at McClellan AFB. This Groundwater OU remedy is designed to prevent the spread of contamination that is already in the groundwater by containing groundwater with concentrations greater than maximum contaminant levels (MCLs). The remedy is also designed to remove to the maximum extent practicable the mass of contamination that lies in that volume of the groundwater.

This remedy does not directly address contamination that currently lies in the vadose zone. To more efficiently achieve overall cleanup, McClellan AFB is developing separate response actions that address the vadose zone areas of contamination directly.

The overall strategy for McClellan AFB is therefore two-pronged in nature. It is designed to contain and remove groundwater contamination at levels above MCLs, preventing exposure to human and environmental receptors (the focus of the remedy described in this document). It also focuses on the vadose zone source areas, preventing exposure at the ground surface and eliminating future downward contaminant migration to groundwater. A discussion of the specific objectives of the Groundwater OU interim response action is presented in Part II, Section D.3, Role of the Groundwater Operable Unit Response Action Within the Overall Cleanup Strategy for McClellan AFB.

C.2 Major Components of the Selected Remedy

The selected remedy has three main components:

- Containment of contaminated groundwater by extraction
- Treatment of the extracted groundwater and offgas
- End-use of the treated groundwater

The selected remedy is Alternative 4A. The rationale for selecting this alternative is presented in the Decision Summary. The selected remedy consists of the following:

- Containment: Groundwater contaminated at levels greater than Levels MCLs will be extracted at pumping rates that prevent its further migration. Containment to prevent offbase plume migration is the highest priority of this remedy, followed by containment of the hot spots and containment to prevent vertical downward migration. Eventually, all groundwater will be contained so that no water above MCLs will leave the Base boundaries. Groundwater extraction wells will also be located in areas with the highest contaminant concentrations (hot spots/sources). Aggressive pumping of these wells will rapidly reduce the total amount of groundwater contamination and its associated risk

- Treatment: Groundwater extracted on the west side of the Base will be treated at the existing groundwater treatment plant (GWTP). The GWTP removes the VOCs from the water by air stripping followed by granular activated carbon polishing. The air stripper offgas is treated by thermal oxidation. Eventually, the extraction system may exceed GWTP capacity. Additional treatment capacity, if needed, will be provided at an east side GWTP using air stripping and granular activated carbon for water treatment and vapor-phase carbon filters for treating the air stripper offgas.

- End-Use: The Air Force believes it is premature at this time to specify any one or any combination of end uses for the treated water in this Interim ROD. The final decision on the end use will be determined in the Final ROD, depending on the actual quantity of water that needs an end use and further discussions with potential recipients of the treated water.

  At this time, the Air Force prefers to reuse as much treated groundwater as possible in the Base's greywater system. The remaining flow will either be discharged into Magpie Creek or injected into the groundwater. This option is discussed in detail in Part II, Section G.3. However, McClellan AFB is continuing to explore with Cal-EPA, U.S. EPA, and surrounding communities how best to utilize the treated water, including providing it to neighboring water districts.

The goal of groundwater containment is to halt the vertical and lateral migration of groundwater that exceeds MCLs. Currently, virtually none of the public is exposed to groundwater contamination from McClellan AFB; containing the groundwater significantly reduces the potential risk of exposure. Contaminant in any area of a plume will be maintained at least until concentrations drop to or below MCLs. The Air Force also plans to isolate the groundwater hot spots, which contain the vast majority of contaminants. Isolation of the hot spots improves long-term cost effectiveness of the remedy. Final cleanup values are not established in this Interim ROD but will be established in the Final ROD, currently scheduled for 2003.

D. Statutory Determinations

D.1 Protectiveness

This interim action is protective of human health and the environment. Protection is achieved at the Base and in the aquifers underlying the Base in the following ways:

- Initial protection of human health will be achieved by stopping the migration of contamination to private and municipal production wells, and by stopping migration to and/or treating water from Base production wells.

- Containment of groundwater within the MCL target volume, by extraction, will protect humans from exposure to contamination above the drinking water standards of the Safe Drinking Water Act.

- Extraction of contaminated groundwater can reduce the downward migration of contaminants and protect the deeper aquifers from degradation.

- Decommissioning Base wells that are believed to be vertical migration conduits, such as BW-18, will protect the deeper aquifers from contaminants migrating from the shallower aquifers. Pumping of BW-18 and other active Base wells also increases the migration rate of contaminants in the A and B Zones into the lower zones.

- Treatment of VOC-contaminated groundwater to appropriate discharge limits prior to discharge will protect the environment from degradation. Discharge limits are presented in Section 1.2.

D.2 Applicable or Relevant and Appropriate Requirements

The selected interim remedy complies with federal and state Applicable or Relevant and Appropriate Requirements (ARARs) for this limited scope action.

D.3 Cost-Effectiveness

The remedy is cost-effective because adequate protection is achieved for the estimated cost of performance. The selected remedy is to control and treat groundwater within the MCL target volume. The analysis contained in the FS and summarized here in Part II, Section I, Selected Remedy, demonstrates that additional remedial action associated with containing and treating the water within the background target volume or the 10-6 cancer risk target volume would not achieve a significantly greater reduction in risk, but would result in higher costs.

D.4 Use of Permanent Solutions, Alternative Treatment, or Resource Recovery Technologies

Although this interim action is not intended to fully address the statutory mandate for permanence and treatment, this interim action of containment of the MCL target volume and treatment of groundwater uses treatment and thus is in furtherance of that statutory mandate. The selected remedy represents the best balance of trade-offs among alternatives with respect to pertinent criteria, given the limited scope of the action. Subsequent actions are planned to address fully the threats posed by the conditions at this OU. A Basewide Feasibility Study (FS) and ROD, scheduled for completion in the year 2003, will fully address any Groundwater OU issues beyond this interim remedy.

D.5 Preference for Treatment as a Principle Element

Because this action does not constitute the final remedy of the Groundwater OU, the statutory preference for remedies that employ treatment and that reduce toxicity, mobility, or volume as a principal element although partially addressed in this remedy, will be addressed by the final response action.

D.6 Site Review

Because this remedy will result in hazardous substances remaining onsite above health-based levels, a review will: be conducted to ensure that the remedy continues to provide adequate protection of human health and the environment within 5 years after commencement of this interim remedial action. Because this is an interim action ROD, review of this site and of this remedy will be continuing as McClellan AFB and the regulatory agencies continue to develop final remedial alternatives for the Groundwater OU.

D.7 Environmental Impact Assessment

The current policy of the United States Air Force is to analyze its response actions conducted under CERCLA for potential environmental impacts as described in the National Environmental Policy Act and as further implemented at 40 Code of Federal Regulation (CFR) Parts 1500 through 1517 and 32 CFR Part 989.

_____ _____

JULIE ANDERSON Date
Director
Federal Facilities Cleanup Office
U.S. Environmental Protection Agency, Region 9

_____ _____

ANTHONY J. LANDIS, P.E. Date
California Environmental Protection Agency
Department of Toxic Substances Control
Chief of Operations
Office of Military Facilities

_____ _____

LAWRENCE P. FARRELL, JR. Date
Lieutenant General, USAF
Vice Commander

Part II: Decision Summary

Part II of this Interim ROD summarizes the information, interpretations, and conclusions that led to McClellan AFB's decision on the remedy, and presents the selected interim groundwater remedy.

A. Site Name, Location, and Description

This section describes McClellan AFB, including its location, topography, climate, land uses adjacent to the Base, surrounding populations, surface and groundwater resources, and surface and subsurface features.

A.1 Site Name and Location

Department of the Air Force
Sacramento Air Logistics Center
McClellan Air Force Base
Sacramento, California 95652

EPA ID# CA4570024337

McClellan AFB, an Air Force Logistics Center, is located approximately 7 miles northeast of downtown Sacramento, California, and covers approximately 2,952 acres. The Base property is approximately bounded by Elkhorn Boulevard on the north, Roseville Road on the south, Watt Avenue on the east, and Raley Boulevard on the west. The Base location is shown in Figure 1.

A.2 Topography

The land surface at the Base slopes gently to the west. Elevations range from 75 feet above mean sea level (msl) on the east side of the Base to approximately 50 feet msl on the west. The topographic relief across the Base is low. Portions of the Base, including parts of Magpie Creek, are within the 100 year flood plain as presented in a flood plain map in the Resource Conservation and Recovery Act (RCRA) Part B application (CH2M HILL, 1992). The Base is approximately 3.6 miles long in the north-south direction and 2.4 miles wide in the east-west direction.

A.3 Climate

McClellan AFB is located in the Sacramento Valley Air Basin (SVAB). Climate in the SVAB is moderate, with mild winters and hot, dry summers.

In January, the average daily maximum temperature is approximately 53°to 54°F. In July, the average daily maximum temperature is 95° to 98°F (University of California, Berkeley, undated).

Mean annual precipitation from 1875 to 1975 in the SVAB was approximately 17 inches. Approximately 90 percent of the rainfall occurs between November and April with little or no precipitation from late spring to early fall. Most of the rainfall is associated with Pacific storms, which are frequent in winter (NOAA, 1989).

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In the winter, northerly and southerly airflow patterns prevail during the day. Calm conditions predominate during the late evening and early morning. During the spring and summer, the prevailing airflow pattern is from the delta or sea breezes. Northerly winds and the sea breeze are predominant in the fall. Full sea breeze conditions occur 29 percent of the year, northerly winds occur 20 percent of the year (CARB, 1984).

A.4 Adjacent Land Use

Land use in the vicinity of McClellan AFB is a combination of military, industrial, commercial, residential, and agricultural uses. Land is not mined for natural resources.

Much of the land around the Base is zoned for residential use. In the Rio Linda area northwest of the Base, most of the land is categorized as agricultural-residential. This land category identifies areas reserved for large-lot, rural residential uses where animals may be kept and crops raised for recreation, educational use, personal consumption, or supplemental income purposes (Sacramento County, 1985). Many of these residences use private well water for nonpotable uses.

Several areas to the north, west, and southeast of the Base have been zoned as industrial-intensive. This land category identifies areas reserved for research, manufacturing, processing, and warehousing activities.

Most of the land to the southwest of the Base consists of low-density residential zones. These areas are reserved for a planned population density range of 5 to 30 persons per acre or a housing density range of 1 to 12 dwelling units per acre. Some of these residences have private wells, but the majority have municipal water supplies.

The land to the east of the Base consists of medium-density residential, commercial, and industrial zones.

Parcels designated for commercial and office use, including shopping centers, large office complexes, and major concentrations of commercial development are also located to the southwest and east of McClellan AFB.

A.5 Surrounding Populations

McClellan AFB is surrounded by four Sacramento County communities that include residential, commercial, and industrial zones. They include Rio Linda and Elverta to the northwest, North Sacramento to the west and southwest, and North Highlands to the east.

The population of the surrounding communities, as determined by the 1980 census, was 107,822. The projected 2005 population is estimated to be approximately 200,000 (Sacramento County, 1985).

A.6 Surface-Water Resources

Surface-water drainage near McClellan AFB occurs predominantly through Magpie, Don Julio, Rio Linda, and Arcade Creeks. Magpie Creek enters McClellan AFB from the east and is joined by several small tributaries before leaving the Base to the west. Onbase drainage has been modified by construction of a series of stone drains and channels across the Base. Runoff from streets and runways is directed into the storm drainage system and exits the Base via Don Julio Creek and Magpie Creek.

Rio Linda Creek crosses the northern portion of the Base. Magpie Creek crosses the southeast and central portions. Arcade Creek is located just south of Base property. All three of these drainages flow into the Natomas East Drainage Canal west of the Base. The canal flows south and west until it discharges into the Sacramento River, just northwest of the confluence of the American and Sacramento rivers (Radian, 1989). Stormwater runoff also exits the base via Don Julio Creek. Groundwater is approximately 100 feet below ground surface. The only interconnection between surface water and groundwater is through infiltration. There are no impacts to surface water quality from adverse groundwater quality.

A.7 Groundwater Resources

Groundwater is used regionally for agricultural irrigation, for potable water supply, for fire fighting, and for industrial uses. Locally, groundwater extracted from the deeper aquifers beneath McClellan AFB is used in the Base water supply for drinking and Base activities. Groundwater extracted from Base-wells is monitored for VOC contaminants. Extracted groundwater from BW-18 is treated using a wellhead GAC unit. There are also several municipal wells located offbase that extract water for potable use (see figure 8). Groundwater extracted from these wells is monitored and contingency plans are being developed if these wells become threatened by contamination.

A.8 Surface

Many buildings located throughout the Base are currently occupied and used for military operations. Several waste pits, underground and aboveground tanks, and storage facilities also exist Basewide. They were installed as part of the historical Base activities. Two hundred fifty-four potential source areas or sites have been identified thus far within McClellan AFB boundaries (McClellan AFB, 1994). Many of these sites have the potential to be contributors to the groundwater contamination problem. Seventy of the sites are classified as waste pits or landfills, 8 are classified as liquid/sludge holding ponds, and 24 are classified as former underground storage tanks (USTs). The remaining sites are generally associated with specific buildings, washracks, pipelines, and storage areas where hazardous materials are routinely used. Table 5-1 of the McClellan AFB Management Action Plan (MAP) describes each of the 254 sites. All are currently being investigated in accordance with CERCLA.

Surface and subsurface features are most dense in Operable Units A, B, C, and D. These operable units will be discussed further in Section B, Site History and Enforcement Activities, and are discussed in detail in Chapter 4, Conceptual Model, of McClellan AFB Remedial Investigation/Feasibility Study (RI/FS) (CH2M HILL, 1994).

A.9 Subsurface Features

McClellan AFB is centrally located within the Great Valley geomorphic province, a wedge-shaped accumulation of sediments, bounded to the west by the Coast Range and on the east by the Sierra Nevada foothills. This area consists of sediments and rock units derived from alluvial, fluvial, flood, and delta deposits of the Sacramento and San Joaquin Rivers, and from alluvial fan accumulations at the base of the Sierra Nevada foothills.

The lithology below the Base consists primarily of sand, silt, and clay in various combinations with localized occurrence of gravel. These deposits were frequently transported and redeposited by local streams. Erosion and redeposition of sediments, and meandering and abandoned channels, make the distinction between soil units difficult.

B. Site History and Enforcement Activities

This section summarizes the history of activities that led to the current contamination, the history of site investigations and interim remedial actions, and the history of enforcement actions. The site investigations and interim remedial actions are summarized chronologically, as follows:

- Initial discovery of contaminated groundwater in 1979
- Activities performed under the Department of Defense (DOD) Installation Restoration Program (IRP)
- Activities performed under the Interagency Agreement (IAG), currently governed by IRP guidelines

B.1 History of Site Activities

McClellan AFB was established in 1936 as an aircraft repair depot and supply base. Prior to this time, the land on which McClellan AFB was constructed had been devoted to agricultural use, primarily raising livestock and growing grain. Base operations expanded significantly during World War II and in subsequent years. The primary mission of McClellan AFB has been to provide logistics and maintenance support for several types of aircraft, as well as maintenance support for several communications and electronics systems. Fulfilling this mission has involved the use of a wide range of toxic and hazardous substances, including industrial solvents and caustic cleaners, electroplating wastes contaminated with heavy metals, oils contaminated with polychlorinated biphenyls (PCBs), low-level radioactive wastes, aviation fuels, and a variety of oils and lubricants. Hazardous wastes from operations at McClellan AFB have historically been discharged to land onbase, in burial pits, landfills, sludge/oil pits or burn pits, or piped through a subsurface industrial wastewater line (IWL) to two industrial wastewater treatment plants (IWTPs) formerly located on the east side of the Base. Sludges from these former IWTPs

were then discharged to land onbase. Most of these former disposal areas were located on the west side of the Base. These land disposal practices were discontinued in the late 1970s. Currently, wastes are sent offsite to approved disposal sites, or discharged to the existing IWTP constructed on the west side of the Base in the early 1970s. Sludges from the existing IWTP are disposed of offsite at approved disposal sites.

B.2 History of Site Investigations and Interim Actions

McClellan AFB voluntarily created a committee in August 1979 to determine if groundwater contamination was present at the Base and in the surrounding community. Trichlorcethene (TCE) was detected in onbase water supply wells, resulting in a study to determine the extent of TCE groundwater contamination, performed in cooperation with state and local agencies. Monitoring of onbase and offbase water supply wells in November 1979 resulted in closure of several wells. A field survey program was initiated, including soil sampling and installation of 15 monitoring wells to determine the sources and extent of onbase TCE contamination. Four areas of TCE contamination were found onbase, designated then as Areas A, B, C, and D. A summary of the investigations performed at McClellan AFB is presented in Table 1.

Table 1

Summary of Major Investigations at McClellan AFB Under IRP and IAG

Year Completed	Contractor	Scope
1981	CH2M HILL	IRP Phase I-initial assessment of contamination. Past disposal sites in all areas of the Base were identified.
1983	Engineering Science	IRP Phase II-Definition and quantification of contamination; implementation of a monitoring program to determine the extent of groundwater continuation
	Ludorff & Scalmanini	Review of previous investigations
1984	Radian Corporation	Determination of the nature and extent of contamination in wells offbase. Public health hazards were identified and remedial alternatives assessed.
1985	McLaren Environmental Engineering, Inc.	Drilling of soil borings to further define the extent of continuation at sites identified during IRP Phase I
1986	Radian Corporation	Groundwater Sampling and Analysis Program. The presence and concentration of contaminants were determined and migration over time was evaluated.
1988	Idaho National Engineering Laboratory	Characterization of the industrial wastewater collection system. Samples were collected and compared to hazardous waste criteria. Also, the integrity of the collection system piping was evaluated.
1989	Radian Corporation	Engineering Evaluation/Cost Analysis-Environmental Assessment
1989	Radian Corporation	Area B Groundwater Operable Unit Remedial Investigation Hydrogeologic characteristics of the southwest portion of the Base were characterized; the horizontal and vertical extent of groundwater contamination was evaluated.
1991	Radian Corporation	Preliminary Groundwater Operable Unit Remedial Investigation. A conceptual model of the hydrogeology was developed and the extent of groundwater contamination at McClellan AFB was investigated.
1993	Agency for Toxic Substances and Disease Registry	Public Health Assessment for McClellan AFB
1994	CH2M HILL	Operable Unit D Remedial Investigation. A remedial investigation was performed to collect enough data to reduce the uncertainty in contaminant type and distribution at OU D. In addition, a risk assessment was conducted further action to determine the extent was recommended.

1994	CH2M HILL	Groundwater Operable Unit Remedial Investigation/Feasibility Study. The conceptual model of the site was expanded a risk assessment was performed; and containment, treatment, and end-use alternatives were developed and screened.
1994	Radian Corporation	Operable Unit C Remedial Investigation and the Operable Units E-H Preliminary Assessment/Site Investigation.
1994	Jacobs Engineering	Operable Unit A Remedial Investigation.

B.2.1 Activities Performed Under the Installation Restoration Program

In 1981, the DOD developed the IRP to identify and evaluate suspected contamination problems resulting from past hazardous waste disposal practices at DOD facilities. The IRP was developed as a four-phase program. Phase I consisted of record searches to identify problem areas. Phase II corresponded to the RI/FS process for characterizing hazardous waste sites and evaluating remedial action alternatives described in the NCP. Phase III involved identification and development of remedial action technologies. Phase IV involved implementation of the recommended remedial action. Until 1990, site investigation activities were performed according to the IRP. After 1990, activities were performed under the IAG, as described in Section B.2.2.

A Phase I records search, performed in 1981, identified groundwater contaminated by TCE as a main area of concern and identified 46 potential hazardous waste storage and disposal areas at McClellan AFB. A Phase II groundwater investigation performed in 1983, involving sampling of Base supply wells, existing monitoring wells, and wells installed during the field program, detected organic and inorganic compounds in the shallow water-bearing zone under McClellan AFB. Also in 1983, McClellan AFB began a quarterly offbase sampling program of 240 private wells located to the west and south of the Base. Results from this sampling program were used to evaluate the extent of offbase contamination and as a basis for providing bottled water to residents with contaminated wells. A second stage of the Phase II groundwater investigation, initiated in 1984, involved installation and sampling of onbase and of offbase monitoring wells and the development of a long-term groundwater monitoring program. In 1986, McClellan AFB provided municipal drinking water hookups for drinking water supplies in the area west of the Base. This remedial action area, presented in Figure 2, included all known areas of offbase groundwater contamination.

Site investigations involving sampling of wastes, soils, and groundwater were performed in Areas A, B, C, D, and other areas of concern in 1984. A Phase III/IV study was performed in Area D in 1985 to evaluate remedial action alternatives and to provide conceptual design information for a selected alternative. An Interim Remedial Measure (IRM) to control further migration of contaminated groundwater was performed in Area D. This IRM included a cap over Area D and installation of a groundwater extraction and treatment system. The cap, composed of layers of clay, compacted soil, a plastic liner, and natural vegetation, was designed to prevent rainwater from percolating through the waste pits. Contaminated sludges and soils were excavated from Area D and sent offsite to an approved disposal site prior to construction of the cap, which was completed in 1986. The groundwater extraction system, also completed in 1986, pumped water from beneath Area D. The groundwater extraction system was expanded to Area C in late 1988 to address possible contaminant migration from the IWTP and nearby disposal areas. Extracted groundwater from Area C and Area D was then piped to the Groundwater Treatment Plant (GWTP), which had been completed in 1987. Further migration of groundwater contaminants in Area B was controlled by pumping BW-18 and by the extraction system constructed under the OU B Engineering Evaluation/Cost Analysis (EE/CA). Well BW-18 receives wellhead treatment using activated carbon. A more thorough discussion of the history and role of the extraction systems, as well as the groundwater treatment methods, is presented in Section D.

B.2.2 Activities Performed Under the Interagency Agreement

In May 1990, the Air Force, U.S. EPA Region IX, and the California Department of Health Services (now known as California Environmental Protection Agency Department of Toxic Substance Control, or Cal-EPA/DTSC) entered into an IAG requiring restoration activities to comply with applicable state and federal laws. At the time, the Base was divided into 8 OUs. Currently the Base is divided into 11 OUs. Ten of the 11 OUs have geographic boundaries at the surface and are associated with source areas at the Base. These OUs are A (formerly Area A), B and B1 (formerly Area B), C and C1 (formerly Area C), D (formerly Area D), E, F, G, and H (see Figure 3). The eleventh OU is the Groundwater OU. An OU is a discrete part of an overall site and can be examined separately if the remedial action for the OU can be done expeditiously, is cost-effective, controls contaminant sources or migration, and is consistent with the final site remedy. RI/FSs have started at the A, B, B1, C, C1, D, and Groundwater OUs. The RI/FS for OU B1 is complete, and an interim ROD has been issued. Results of that study show that the principal pathways of exposure at OU B1 were associated with PCBs and dioxins/furans in surface soil. Contaminants in soil at OU B1 are not considered to represent significant sources of groundwater contamination. OUs E through H are deemed to be lower priority areas, with an RI/FS for these OUs to be initiated in the 1996-1997 timeframe.

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Removal actions for VOCs in soil, such as TCE, that could migrate to groundwater in the future were addressed in an EE/CA prepared in 1993. The EE/CA supports the use of Soil Vapor Extraction (SVE) for a Basewide nontime-critical removal action for VOC contamination in soil at McClellan AFB. An SVE treatability study was initiated in OU D in 1993 that has become a removal action. Additional SVE removal actions were initiated in OUs B and C1 in 1994.

The Preliminary Groundwater Operable Unit Remedial Investigation (PGOURI) began in 1990. Its purpose was to develop a conceptual model of the hydrogeology and groundwater flow patterns under McClellan AFB and to further define the extent of groundwater contamination. Results from the PGOURI indicated that several contaminants have been consistently detected in groundwater under McClellan AFB at levels above federal drinking water standards. The contaminant with the greatest spatial extent in groundwater under McClellan AFB is TCE.

Groundwater monitoring is performed by the Groundwater Sampling and Analysis Program (GSAP). The GSAP, which has been ongoing since October 1986, has involved quarterly sampling and analysis of groundwater contaminants and measurement of water levels from onbase and offbase monitoring wells. There are currently 300 onbase and offbase monitoring wells.

The Groundwater OU RI/FS proposed plan, released for public comment in July 1994, included PGOURI and GSAP data as they relate to estimating the extent of groundwater remedial action required and implementing the remedial action. The plan included estimated target volumes of groundwater for remedial action, risk assessment, and modeling of groundwater flow directions under McClellan AFB. It also evaluated remedial action alternatives, considering the uncertainties in the understanding of the nature and extent of groundwater contamination at McClellan AFB.

B.3 History of Enforcement Actions

Since 1979, McClellan AFB has acted voluntarily to respond to groundwater contamination. Since 1981, McClellan AFB has responded to groundwater contamination problems in accordance with the IRP. Several investigations and IRMs were performed under the IRP, as described previously. On

July 22, 1987, McClellan AFB was listed on the U.S. EPA's National Priorities List (NPL). On May 2, 1990, the Air Force, U.S. EPA Region IX, and Cal-EPA signed the IAG, which requires compliance with the NCP, CERCLA guidance and policies, RCRA guidance and policies, and applicable state laws. Under the IAG, the Air Force agreed to undertake, seek adequate funding for, fully implement, and report on RIs, FSs, all response actions, and operation and maintenance of response actions. The IAG specifies deadlines and target dates for documents. The IAG fulfills the Federal Facility Agreement under CERCLA Section 120.

Several interim groundwater actions have taken place at McClellan, including groundwater extraction systems, surface capping, and construction of the west side treatment plant. These actions are summarized in Table 2. All current extraction systems will be included in the remedy presented in this Interim ROD. These extraction systems do not completely contain all groundwater contamination in OUs B, C, and D.

A review of grants (leases, permits, licenses, and easements) at McClellan AFB was performed in 1979 during the IRP Phase I records search to identify other potentially responsible parties. The records search documented existing grantees (users of McClellan AFB property) or grantors (owners of property being used by McClellan AFB), their purposes, and types of agreements. Review of these records indicated that none of the existing grants involved activities that could have resulted in releases of hazardous substances.

This Interim ROD would effectively transfer the current removal actions, i.e., operation of the current extraction systems in OUs B, C, and D, into part of the remedy presented in this document.

Table 2

Summary of Existing Groundwater Interim Actions

Groundwater Interim Actions

Facility	Mechanism	Date Online	Well Name	Zone	Current Flow Rate (gpm)	Current Treatment
Three OU B Wells	OU B EE/CA Removal Action	1993	EW-246	A	10	Conveyed to west side groundwater treatment plant (GWTP)
			EW-63	B	10	
			EW-247a	C	200	
Two IC 1 Wells	Removal Action	1990	EW-233	A	5.2	Wellhead treatment
			EW-234	A	1.6	
Four OU C Wells	Voluntary	1988	EW-137	B	7.7	Conveyed to west side GWTP
			EW-140	B	25.4	
			EW-141	C	17.2	
			EW-144	B	19.2	
Six OU D Wells	Voluntary/ Commitment to Groundwater Hazardous Waste Task Force	1987	EW-73	A/B	20.5	Conveyed to west side GWTP
			EW-83	A/B	6.1	
			EW-84	A/B	6.5	
			EW-85	A/B	11.7	
			EW-86	A/B	12.2	
			EW-87	A/B	12.3	
West side GWTP-Air stripping and granular activated carbon-thermal oxidation processes	Voluntary/ Commitment to Groundwater Hazardous Waste Task Force	1987	NA	NA	NA	Currently treats groundwater from OUs B, C, and D. Has capacity to treat higher flows

BW-18 Wellhead Treatment	Safe Drinking Water Act	1985	NA	NA	NA	BW-18 is a Base supply well located within OU B. Its radius of influence is about 500 to 700 feet in the A and B aquifers and is slightly higher in the C aquifer because of a larger screened interval. The well was out of service from 1981 to 1985 as a result of detected contaminant concentration. BW-18 currently receives wellhead treatment that effectively removes any contamination before releasing the water into the McClellan AFB water supply.

Other Interim Action

Facility	Enforcement Mechanism	Date Concentrated	Notes
OU B1 Cap	Interim ROD (1993)	1994	Constructed to prevent surface-water infiltration, further vertical migration, and exposure of contamination to the public
OU D Cap	Voluntary	1985-86	Constructed to prevent surface-water infiltration, further vertical migration, and exposure of contamination to the public

a EW-247 is not currently in operation. It is expected to be in operation in mid-1995.

C. Highlights of Community Participation

McClellan AFB conducts a comprehensive effort to inform the public and involve the community in the environmental decision-making process. Central to McClellan AFB's community relations program is the following six-point strategy:

1. Emphasize open communications and free information flow with regulators, media, and the public

2. Emphasize community involvement in decision processes

3. Be responsive to real community needs

4. Press to solve problems quickly

5. Seek to attain fair media coverage

6. Maintain credibility with the media, regulators, and the public

Following are the highlights of the community relations activities that have taken place at McClellan AFB to date:

- Interagency Agreement (IAG). The Air Force, EPA, and Cal-EPA/DTSC have negotiated an interagency agreement, which includes requirements for community relations activities based on provisions in federal (and where applicable, state) statutes, regulations, and guidelines.

- Administrative Record/Information Repository. An Administrative Record of information that has been used to support Air Force decision making related to the IRP has been established at McClellan AFB. The Administrative Record is staffed full-time by people who are in the process of converting more than 10 years of documentation to microfilm. In addition, a public information repository for the relevant portion of the Administrative Record and its index has been established at McClellan AFB and Rio Linda/Elverta Community Center.

- Community Relations Plan (CRP). The first McClellan AFB CRP was approved in August 1985 and revised in 1988. A further revision was prepared in January 1991. This CRP is currently being implemented under the direction of the McClellan AFB Remedial Project Manager (RPM), and is being updated, based on the continued monitoring of community concerns and a series of community interviews conducted in August, September, and October 1992.

- Technical Review Committee (TRC). The TRC has met quarterly since October 1990. In addition to Air Force, EPA, state, and congressional representatives, the TRC includes representatives from the County and City of Sacramento and the local American Federation of Government Employees (AFGE) union. TRC meetings provide updates on all IRP activities for the previous quarter, indicate plans for the upcoming quarter, and allow representatives a forum for discussion of progress and plans. The TRC has transitioned into the Restoration Advisory Board (RAB) as of September 1994.

- Mailing List. A mailing list of all interested parties in the community is maintained by McClellan AFB and updated regularly. The mailing list has grown from 200 names in 1984 to 2,600 names in 1992. This mailing list has also been used by the Agency for Toxic Substances and Disease Registry (ATSDR) to distribute information on public health studies.

- Fact Sheets and Newsletters. Newsletters describing the status of the IRP at McClellan AFB have been distributed to the mailing list since May 1984. Up to four fact sheets per year have been published and distributed on an as needed basis.

- Open Houses. Informational meetings on the status of IRP efforts at the Base have been held with the public at least twice a year since 1983, or more frequently as required by current events, and these meetings are properly publicized by the media. The meetings are used to answer the public's concerns and to update citizens on the progress of the IRP.

- Press Releases. Press releases have been issued on an as-needed basis for activities, decisions, updates, and milestones associated with the cleanup effort. In addition, environmental programs are frequently the subject of articles in the Base newspaper, The Spacemaker, which is available to all workers and visitors to the Base.

- Environmental Community Relations Steering Committee (ECRSC). The ECRSC has met quarterly since October 1987 to monitor issues that affect the public and to recommend community relations activities. Membership includes congressional, agency, public, and Air Force representatives.

- Videotape and Brochure. An Environmental Management videotape and a brochure have been prepared and distributed to describe IRP goals and progress at McClellan AFB.

McClellan AFB has had an active community relations program since 1983. The RI/FS and Proposed Plan for the Groundwater OU were both released to the public in June 1994. These two documents are made available to the public in the Administrative Record maintained at McClellan AFB. The notice of availability of these documents was published in the Sacramento Bee and the Spacemaker. The Proposed Plan was mailed to all parties on the McClellan AFB mailing list, government officials, representatives of interested community groups, and members of the media.

A 30-day public comment period was held from July 6, 1994, through August 5, 1994. A public meeting was held on the evening of July 20, 1994 from 7:00 p.m to 9:00 p.m. At this meeting, representatives from the Air Force, Cal-EPA/DTSC, the RWQCB, and EPA answered questions about contamination at McClellan AFB and the remedial alternatives under consideration. A formal presentation about the proposed cleanup plan was made by the Air Force. A transcript of this public meeting is part of the Administrative Record.

A Responsiveness Summary addressing oral and written comments received during the public comment period was developed and is attached to this Interim ROD. This decision document presents the selected remedial action for the Groundwater OU at McClellan AFB, which was chosen in accordance with CERCLA, as amended by SARA, and to the extent practicable, with the NCP. The decision for the Groundwater OU Interim ROD at McClellan AFB is based on documents found in the Administrative Record.

D. Scope and Role of the Groundwater Operable Unit Within the Site Strategy

This section includes the rationale for undertaking the limited action on the groundwater, the scope of the Groundwater OU response action, the role of the Groundwater OU response action within the over all cleanup strategy for McClellan AFB, and a description of the consistency between the Groundwater OU response action and future remedial actions at McClellan AFB.

D.1 Rationale for Undertaking this Limited Action at McClellan AFB

The overriding goal of the McClellan AFB IRP is to reduce risk to public health and the environment. This goal must be met within the CERCLA process, the Air Force IRP protocols, and resource constraints. The immediate risk is reduced by implementing actions such as the operation of the groundwater extraction systems at OUs B, C, and D. Removal and remedial actions under CERCLA require decision documents prior to implementation. The appropriate decision documents are action memorandums for removal actions and Records of Decision for remedial actions.

The CERCLA process recognizes that a site may need actions that are larger in scope than a removal action, even before enough information can be gathered to prepare a final ROD. To fill this need, EPA encourages the use of Interim RODs so that as many remedial action decisions as possible can occur at the earliest point in the site investigation.

The decision documents (action memorandums, Interim RODs, and RODs) are supported by the Administrative Record in general, and by the Proposed Plan, EE/CA, or RI/FSs, in particular. This Interim ROD is supported by the Groundwater OU RI/FS. Information is insufficient to support a final groundwater ROD.

Remedial action cleanup goals for the Groundwater OU are presented in this Interim ROD; remedial action cleanup standards will be set in the Final ROD. Remedial action cleanup goals have been established based on current information but are subject to change prior to the Final ROD. Remedial action cleanup standards documented in the Final ROD are fixed and are not subject to change except through amendment of the ROD.

D.2 Scope of the Groundwater OU Response Action Within the Site Strategy

This interim action is designed to capture and contain all groundwater contamination derived from McClellan AFB activities that exceeds the MCLs, thereby preventing future lateral and vertical migration of contaminant plumes. The groundwater interim action will make use of new extraction, treatment, and end-use systems as described in Section I, as well as maintain existing groundwater extraction systems in OUs B, C, and D.

McClellan AFB currently has several groundwater removal actions in place (as described in Table 2). Groundwater extraction is currently taking place in OUs B, C, and D to limit offbase subsurface migration. Built in the mid-1980s, the GWTP is located on the west side of the Base and receives water from OUs B, C, and D. The plant uses air stripping processes and granular activated carbon-thermal oxidation processes to remediate groundwater and to treat emissions. The existing actions are considered part of the baseline conditions in the RI/FS and will become part of the remedy. The existing west side treatment plant will be expanded to accommodate a higher groundwater influent flow rate, as well as different influent concentrations from what it presently receives. New extraction wells will be installed as part of this interim remedy in the west and east parts of the Base. Ground water pumped from current and future extraction wells located on the west side of the Base will be conveyed to the west side treatment plant. Groundwater pumped from new extraction wells located on the east part of the Base will be piped to a new east side treatment plant, if required.

D.3 Role of the Groundwater Operable Unit Response Action Within the Overall Cleanup Strategy for McClellan AFB

Eleven operable units have been identified at McClellan AFB. Of these, 10 are actually contaminant source areas in the vadose zone (soils above groundwater) and are not the direct focus of this groundwater response action. The eleventh OU, and the focus of this Interim ROD, is the Groundwater OU.

The Groundwater OU, unlike the other OUs, spans the entire Base because groundwater contamination does not recognize geographical OU boundaries. The Groundwater OU response action described in this document is designed to address the Basewide groundwater contamination problem.

The Groundwater OU response action has the following specific remedial response objectives:

- Protect public health and the environment from exposure to contaminated groundwater.
- Contain the groundwater contamination by stopping lateral migration offbase and vertical migration to deeper aquifers.
- Achieve compliance with ARARs.

This Groundwater OU remedy is designed to prevent the spread of contamination that is already in the groundwater and to remove to the maximum extent practicable the mass of contamination that lies in the groundwater. This remedy does not directly address contamination that currently lies in the vadose zone. Only when contamination migrates downward from the vadose zone source areas and enters the groundwater will it be addressed by this Groundwater OU remedy. The only exception will be the remediation of the vadose zone in areas where two-phase extraction will take place.

To achieve overall cleanup more efficiently, McClellan AFB is developing separate response actions that address the vadose zone areas of contamination directly. An interim "Plug-in" ROD is being developed that will function as the primary decision document for the majority of contaminated vadose zone areas at McClellan AFB. Some areas of vadose zone contamination may not be supported by the vadose zone Plug-in ROD decision document. For such areas, individual ROD or IROD documents will be prepared to support remedial action prior to issuance of the Final Basewide ROD.

In addition, a variety of innovative treatment technologies will be evaluated as part of the ongoing Basewide RI. These treatability studies will provide information to allow for possible selection of innovative technologies as part of the remedy. Individual Interim ROD documents will also be prepared to support the incorporation of innovative technologies into the Basewide remedy.

Given the risk reduction goal of the McClellan AFB IRP and the CERCLA process, the following decision documents have been prepared or are planned:

- Interim Record of Decision for PCB-, dioxin-, and metals-contaminated soils at OU B1. Completed September 3, 1993.

- Soil vapor extraction (SVE) EE/CA to support Removal Action for areas highly contaminated by VOCs in the vadose zone. Completed November 1993.

- International ROD for the Basewide Vadose Zone. Scheduled to be completed in the fall of 1995.

- Additional Interim RODs for contamination or conditions that do not fit the Interim ROD for the Basewide Groundwater OU or the Interim/Final ROD for the Basewide Vadose Zone. Dates not known because need for additional documents is not yet determined.

- Basewide ROD. Scheduled to be completed March 15, 2003.

D.4 Consistency of this Groundwater Response Action with Future Actions at McClellan AFB

As described in Sections G, H, and I of this document, the response action for the Groundwater OU will use groundwater pump and treat technology. This technology involves installing an array of groundwater extraction wells into the contaminated aquifers, pumping the water and conveying it through pipelines to a treatment system, and routing the treated water to an appropriate point of end use. These extraction, treatment, and end-use systems will generally be consistent with other remedial actions that will occur at McClellan AFB to address contamination in the vadose zone.

The groundwater interim remedy will be implemented in phases spanning several years. Ongoing site characterization will be conducted concurrently under the Basewide RI. Data collected from the RI will be used in the implementation of the selected remedy.

Future actions that may eventually be implemented at McClellan AFB include SVE systems, construction of impermeable caps, and excavation of contaminated soils. The groundwater response actions will be adequately designed to be consistent with these other actions and not to interfere with them.

With proper planning, synergy may be developed between these future actions and the groundwater response action. For example, when groundwater extraction wells are installed, soil or soil gas samples may be collected to define the depth of contamination in the vadose zone. Such data may be used to better design SVE systems, impermeable caps, or excavations.

In some instances, the groundwater remedy described in this document may need to be slightly modified to accommodate the implementation of vadose zone actions that will occur in the future. For example, if excavation of contaminated soil is necessary at a site that is traversed by conveyance pipelines, the pipes may need to be rerouted in a manner that will not interfere with the excavation.

E. Summary of Site Characteristics

This section summarizes the source area information, the hydrogeologic conditions, the contaminants of concern, the extent of contamination, and the data gaps that still exist. The summary of hydrogeologic conditions includes the following:

- Sources of groundwater contamination
- Explanation of the monitoring zone designations
- Historic movement of groundwater
- Horizontal groundwater flow
- Vestical groundwater flow
- Regional pumping
- Water table decline

E.1 Base Source Areas

As discussed in Section B, Site History and Enforcement Activities, McClellan AFB developed a program to investigate and evaluate past operation and waste disposal practices, identify contamination sources, and determine the extent of contamination in soil and groundwater (Radian, 1990).

At present, 254 sites have been identified as sources of soil and groundwater contamination around the Base (Radian, 1991). The locations of these source areas are presented in Figure 3. Both confirmed sites (CSs) and potential release locations (PRLs) are presented in more detail and discussed in Chapter 4, Conceptual Model, of the Groundwater OU RI/FS (CH2M HILL, 1994). Nearly 90 percent of the CSs and PRLs are located within the boundaries of OUs A, B, C, and D. Contamination has been detected at OU G/H, and a detailed investigation is currently being conducted. Because the Css and PRLs were used for specific functions and operations, each OU contains its own history of maintenance activities, contamination discharges, waste production, and contaminant detection.

E.2 Hydrogeologic Conditions

E.2.1 Monitoring Zone Designations

The groundwater subsurface is divided into five distinct monitoring zones (A, B, C, D, and B) based primarily on geophysical logs between pilot borings (Radian, 1992). Approximate zone depths and thicknesses are presented in Table 3.

As discussed in Chapter 4, Conceptual Model, in the Groundwater OU RI/FS, strong evidence suggests that the groundwater system functions more as a single unit than as separate hydrostratigraphic units. The following observations suggest that the units are hydraulically linked:

- The lithology is heterogeneous, indicating no laterally continuous aquifers or aquitards.
- Water levels and flow directions in the monitoring zones are similar.
- The influence of regional pumpage is observed in all monitoring zones without significant time lags.
- Stiff and Piper diagrams show that the inorganic water quality in all zones is similar.

Table 3
Appropriate Zone Depths

Zone	Parameter	OU A	OU B/C	OU D	OU G	
Ground Surface (ft msl)		70	62	62	72	
A	Zone Thickness (ft)	20	35	35	20	.
	Elevation (ft msl)	-35 to -55	-45 to -80	-37 to -72	-30 to -50	
	Depth (ft bgs)	105 to 125	107 to 142	99 to 134	102 to 122	
B	Zone Thickness (ft)	50	65	60	40	1
	Elevation (ft msl)	-55 to -105	-80 to -145	-72 to -132	-50 to -90	
	Depth (ft bgs)	125 to 175	142 to 205	134 to 194	122 to 162	.
C	Zone Thickness (ft)	70	75	80	55	l.
	Elevation (ft msl)	-105 to -175	-145 to -220	-132 to -212	-90 to -145	
	Depth (ft bgs)	175 to 245	205 to 282	194 to 274	162 to 217	
D	Zone Thickness (ft)		88			
	Elevation (ft msl)	Data not available	-220 to -308	Data not available	Data not available	
	Depth (ft bgs)		282 to 370			
E	Zone Thickness (ft)		52			
	Elevation (ft msl)	Data not available	-308 to -360	Data not available	Data not available	
	Depth (ft bgs)		370 to 422			

Note: Zone thicknesses were estimated from the PGOURI (Radian, 1992).

The monitoring zones serve to provide a basis for discussing the data by depth interval, but do not represent distinct lithologic or hydrostratigraphic units.

E.2.2 Historic Movement of Groundwater

During this century, groundwater has been pumped from the areas surrounding McClellan AFB for irrigation and municipal or domestic water supply. As a result of the pumping, more groundwater has been extracted for use than has been supplied by natural recharge. The water level within the aquifer system has been dropping continuously for approximately 50 years. At the present time, the only discharge of groundwater is by pumping of irrigation and supply wells and by operating the Base's remedial extraction system.

Historic groundwater flow directions have varied greatly over the past 80 years. They have ranged from the northwest direction to the south direction. Current groundwater flow in Monitoring Zones A, B, C, D, and E is generally from the northeast to the southwest in OU A and northwest to southeast in OU B/C. Average groundwater flow velocities are 10 to 110 ft/yr in OU A, and 25 to 110 ft/yr in OU B/C. Historic groundwater flow contours are presented in Figure 4. Declines and changes in groundwater flow can be determined from these contours.

E.2.3 Horizontal Groundwater Flow

Base production wells, offbase production wells, extraction wells, and regional pumping all affect the local groundwater flow directions at the Base. Some uncertainty exists in the calculation of groundwater flow velocity because the aquifer's hydraulic conductivity is not well defined.

Groundwater contour maps for the A, B, and C Zones are presented in Figures 5, 6, and 7, respectively. They are based on water-level measurements collected in January 1993.

In the southern part of the Base (OU B), BW-18 has a high pumping rate; therefore, groundwater locally moves toward BW-18 from all directions. BW-18 is perforated in the C through E Zones to a depth of 400 feet and pumps at an average rate of approximately 1200 gpm with a capacity to pump 1,600 gpm.

There are currently 15 remedial extraction wells onbase: five in OU B, four in OU C, and six in OU D. The OU D extraction wells also have a significant local influence on groundwater flow paths. The six OU D extraction wells appear to have captured the contaminated groundwater in Monitoring Zones A and B beneath the source areas. Effects of the OU C extraction system in Monitoring Zone B are also observable. The effects of the OU B extraction system are less apparent because of the super imposed influence of the adjacent BW-18 and the low flow rate of these extraction wells.

E.2.4 Vertical Groundwater Flow

The vertical hydraulic gradients that exist at the Base are predominantly downward, except in areas where shallow extraction is occurring. This downward gradient is mainly the result of regional pumping withdrawals. Consequently, water moves on a downward gradient from the recharge area (ground surface) to the discharge area (regional aquifer).

This pervasive downward gradient has implications on the movement of contamination at the Base. Contaminated groundwater will move horizontally in response to the horizontal gradients, but will also move vertically in response to the downward gradient The vertical gradients between the A and B Zones are slightly downward at a gradient of -0.01 to -0.10 in OU A, -0.01 and -0.15 in OU B, and -0.10 to -0.15 in OU C. Vertical gradient is a measure of the difference in head elevations vertically Positive vertical gradients suggest upward groundwater flow; negative vertical gradients suggest downward groundwater flow.

Because the horizontal hydraulic conductivity of the layered sediments is about 5 to 15 times the vertical hydraulic conductivity, contaminants will move further in the horizontal plane. However, unless groundwater extraction is initiated in the shallow aquifers at the site, contamination will continue to move downward into deeper units and eventually threaten regional municipal supply wells.

E.2.5 Regional Pumping

The historical and current pumpage of Base, municipal, and domestic wells have affected the groundwater flow directions. Except for the hydraulic control of the OU D extraction wells, groundwater generally flows to the southern portion of the Base in all zones. This is due primarily to the large pumping influences of BW-18 and the municipal wells located to the south of the Base.

Generally, higher pumping occurred in the southwest and northeast regions of the Base. The aquifer beneath McClellan AFB receives recharge from the American River to the south, from the Sacramento River to the west, from various small creeks to the north, and from mountain-front recharge from precipitation to the east.

Locations of all known production wells on and adjacent to the Base are presented in figure 8. A complete listing of the available information on the regional pumpage and supply wells is included in the Groundwater OU RI/FS report. According to pumpage data compiled in the Groundwater OU RI/FS, the estimated groundwater withdrawal from the regional aquifer within 5 miles of McClellan AFB was at least 53,000 acre-feet per year, or 33,000 gpm. The RI/FS further estimates that the total groundwater extraction required for capture of the MCL target volume at McClellan AFB is about 1,100 gpm. This represents approximately 3 percent of the total groundwater withdrawal in the vicinity of McClellan AFB, if it is assumed that the total regional withdrawal is only 33,000 gpm. The percentage of total regional groundwater withdrawal represented by McClellan AFB remedial pumping is actually significantly smaller for two reasons:

- Pumpage data were available for only 60 to 70 percent of the production wells within a 5-mile radius of McClellan AFB, and the total pumpage from this area is likely significantly larger than the 53,000 acre-feet per year cited in the RI/FS.

- The 20 square miles contained in the 5-mile radius centered on McClellan AFB represent only a fraction of the groundwater basin beneath the Sacramento urban area that contributes groundwater to the regional aquifer beneath McClellan AFB (see regional groundwater contour maps presented in the RI/FS). Therefore, the total regional groundwater withdrawal from the area is also larger.

Remedial pumping planned for McClellan AFB will have no influence on streamflow in the area. Therefore, the depth to groundwater in the vicinity of the Base is approximately 100 feet, and streams in the area are not in direct hydraulic connection with the groundwater system. Small additional declines in groundwater levels near extraction wells will have no influence on the rate of infiltration from local streams.

E.2.6 Water Table Decline

Agricultural and domestic demands on groundwater have contributed to the regional water table decline. Recent declines beneath McClellan AFB are due primarily to a combination of Base and extraction well pumping superimposed on the regional decline. Within the last 10 years, water levels in Monitoring Zone A have declined at a rate of 1 to 2 feet per year. As a result of this decline, several Zone A monitoring wells onbase have already been abandoned or converted to soil vapor monitoring wells.

The groundwater table currently is approximately 100 feet bgs. No interconnection exists between surface water and groundwater except for infiltration. Groundwater quality does not affect surface water quality.

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E.2.7 Sources of Groundwater Contamination

Disposal activities and waste management practices at McClellan AFB have substantially improved over the years. There may be some continuing sources of contamination to groundwater resulting from McClellan AFB's operations, but the vast majority of industrial releases have been eliminated. The historical sources of groundwater contamination have been discussed in Section B.1, and are shown in Figure 9. The current sources of groundwater contamination are the contaminated vadose zone, and the non-aqueous phase liquid (NAPL) pools in the vadose zone and groundwater. Current sources are defined as the contaminated areas that must be remediated for the groundwater remedial actions to be fully effective.

NAPLs are immiscible fluids that may be present in the vadose zone and in the groundwater. There are two classifications of NAPLs: light and dense. The classification of a NAPL is based on the unit weight of a NAPL compared to the unit weight of water. Light NAPLs (LNAPLs) are lighter than water and will float if they reach the water table. DNAPLs are heavier than water and will sink should they encounter the water table. The contaminants of concern (COCs) identified in the ground water beneath McClellan AFB are DNAPLs. Although the presence of DNAPLs has not been confirmed at McClellan AFB, TCE has been measured in the groundwater at above 1 percent of its solubility. This does not confirm presence of DNAPLs, but is a strong indicator that TCE DNAPLs are present, especially near the hot spots.

The areas suspected to contain DNAPLs are two hot spot areas in OU A; two hot spots in OU B, one hot spot in OU C, and two hot spots in OU D.

Contamination in the groundwater is derived from the migration of contamination downward through the vadose zone. This downward migration occurs through two primary mechanisms: gravity and hydraulic loading. Hydraulic loading can occur as a result of precipitation percolation, surface-water discharge to the ground surface, and IWL leaks, broken water lines, and unlined waste pits. Contaminant migration to the groundwater can occur only in areas where vadose zone VOC contamination is large. DNAPL presence may be inferred if soil gas concentrations are detected in excess of 1 x 10-5 ppbv. Such contaminant levels will generally only be found in vadose zone source areas, such as abandoned waste pits.

Downward migration of contamination through percolating precipitation can occur anywhere contamination is present, so long as the ground surface is not capped or sealed to prevent water entry. DNAPLs may also exist in the groundwater, and are especially likely to be found in groundwater hot spots located in Monitoring Zone A. Such DNAPL also represents a long-term contaminant source to the groundwater because of the dissolution of contamination from the DNAPL pool into the groundwater. Thirty-five Base production wells have been identified. Locations of these Base production wells are presented in Figure 8. These 35 Base wells were used for Base activities. Almost all of these wells have been scheduled for decommissioning for the following reasons:

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- The aquifers from which they pump are contaminated
- The Base wells may serve as vertical conduits for migration of contaminants
- The pumpage from these wells may cause contamination in the shallower zones to be drawn into the deeper zones

The decommissioning program began in 1991 and is divided into phases. Four wells were decommissioned in 1991 during Phase I, 9 wells were decommissioned in 1992 during Phase II, and 15 wells are scheduled to be decommissioned during Phase III, which began in April 1994. One well was abandoned in 1984, one well has not been identified, and two wells are located offbase. Three wells, BW-10, BW-18, and BW-29, are currently active. BW-18 is scheduled to be decommissioned and replaced as described in this Interim ROD. Base well decommissioning will continue in Phase IV, which is scheduled to begin in mid-1995.

E.2.8 Smear Zone

The decline of the water table in areas of significant groundwater contamination results in contaminants remaining adsorbed to soil particles and dissolved in the residual water of the vadose zone. This process creates what is commonly referred to as the "smear zone." The smear zone is approximately 60 to 70 feet thick. As the water table declines, the thickness of the smear zone increases. The following processes contributed to the development of the smear zone:

- Historically, water levels were close to the bottom of waste pits and source areas. Contaminants migrated from these source areas to the groundwater at the water table interface or into rainwater that was infiltrating through the vadose zone to the water table.

- As the water table declined, a portion of the contaminants remained in solution in the groundwater, partitioned into soil gas, and sorbed onto soil particles, depending on their relative phase partitioning tendencies. The smear zone is made up of contaminants that volatilized into the soil gas and were dissolved in residual soil water or that were adsorbed onto soil particles while the water table declined.

- Prior to the operation of SVE systems, contaminants in the soil gas have migrated primarily under diffusive concentration gradients. Compounds sorbed to soil surfaces are considered immobile, except for the component that is flushed from the soil particles by infiltration of precipitation.

- Contaminants that remained in the groundwater have been migrating primarily with groundwater flow driven by vertical and horizontal gradients.

Current Base activities influencing the smear zone are shown in Figure 10.

Groundwater levels in the vicinity of McClellan AFB have been declining historically at a rate of 1 to 2 feet per year. These falling water levels have resulted in the creation of a smear zone, in which contamination originally contained in the groundwater system is retained in unsaturated zone soils.

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The long-term water level decline is caused by a regional imbalance in the water budget for the aquifer in the Sacramento area. Total groundwater production from the basin has exceeded natural recharge over the long term, and groundwater levels have declined as a result. Because McClellan AFB's remedial pumpage represents such a small proportion of the total groundwater withdrawal from the basin, it will have little impact on the regional water level trends in the vicinity and, therefore, little impact in the generation of a smear zone. The only areas where groundwater pumpage at McClellan AFB may significantly increase the thickness of the smear zone are near individual extractions wells, where the cone of depression created by pumping may result in a local increase in smear zone thickness.

E.3 Contaminants of Concern

TCE, cis-1,2-DCE, PCE, and 1,2-DCA were determined to be contaminants of concern (COCs) in the Groundwater OU RI/FS (CH2M HILL, 1994). The COCs were selected based on the following criteria:

- Frequency of detections
- Concentration measurements above MCLs
- Health risk posed by contaminant

The four COCs, their MCLs, and summary statistics are presented in Table 4.

Table 4
Summary Statistics of COCs

COCs	MCL (µg/l)	Mean (µg/l)	Frequency of Detects (%)	Maximum Detect (µg/l)	Water Solubility (µg/l)	Partition Coefficient
TCE	5	45.30	51	26,000	1,000,000	126
cis-1,2-DCE	6	3.54	26	210	3,500,000	32
PCE	5	13.61	11	2,100	150,000	661
1,2-DCA	0.5	1.70	9	120	8,690,000	14

Note:
1. Statistics from data set presented in Chapter 4, Conceptual Model, of the Groundwater OU RI/FS (CH2M HILL, 1994).
2. Mean calculated with nondetects as zero.
3. Water solubility and partition coefficient are at 25°C.

The COCs are all VOCs. VOCs collectively exhibit a wide range of partitioning and mobility characteristics. In the groundwater, VOCs can partition into the soil, into groundwater, or exist as free product, known as NAPLs. Contaminants dissolved in groundwater migrate with the groundwater. Contaminants sorbed to soil are immobile until they dissolve in the groundwater. NAPLs can migrate either under gravity or after they have partitioned into the groundwater. The partitioning of contaminants from a sorbed state or free product to groundwater is a slow process that is driven by concentration gradients.

The tendency of VOCs to dissolve into groundwater, sorb to soil, or exist as free product is measured by their water solubility, and partition coefficient. The parameters of the COCs are listed in Table 4.

The water solubility measures the tendency of contaminants to partition between NAPLs and water. 1,2-DCA has high water solubility and would tend to dissolve into groundwater more than cis-1,2 DCE, TCE, or PCE. Conversely, cis-1.2-DCE, TCE, and PCE would tend to exist as NAPLs more readily than 1,2-DCA. The partition coefficient measures the tendency of contaminants to partition between water and soil. PCE has a higher partition coefficient and would tend to sorb to soil more than 1,2-DCA, TCE, and cis-1,2-DCE. Conversely, the 1,2-DCA, TCE, and cis-1,2-DCE would tend to remain dissolved in groundwater more than PCE.

The mass of the four COCs in the groundwater is estimated to be approximately 21,000 pounds (9,600 kg). The mass of the COCs and the volume of contaminated aquifer are presented in Table 5. TCE is the most prevalent COC. The volume of aquifer with TCE concentrations greater than non-detectable levels occupies approximately 2.2 billion, 1.3 billion, and 1 billion cubic feet in Zone A, Zone B, and Zone C, respectively, totaling 4.6 billion cubic feet. In addition, approximately 17,000 pounds (7,900 kg) of TCE exist in Zone A, 880 pounds (400 kg) of TCE exist in Zone B, and 380 pounds (170 kg) of TCE exist in Zone C, totaling 19,000 pounds (8,500 kg) of TCE in all three zones.

Table 5
Estimated Mass of COCs and Volume of Contaminated Aquifer By Zone
Groundwater Operable Unit

Contaminants of Concern	Zone A	Zone B	Zone C	Total
TCE				
Mass (lb)	17,000	880	380	19,000
Volume (million ft3 of aquifer)	2,200	1,300	1,000	4,600
PCE				
Mass (lb)	1,700	73	0	1,700
Volume (million ft3 of aquifer)	180	250	0	420
cis-1,2-DCE				
Mass (lb)	380	95	75	550
Volume (million ft3 of aquifer)	1,100	510	550	2,200
1,2-DCA				
Mass (lb)	40	21	0.13	60
Volume (million ft3 of aquifer)	130	830	0.06	970
Total COC				
Mass (lb)	19,000	1,100	460	21,000
Mass (kg)	8,636	500	209	9,545

Notes:

1. Volume and mass estimates are for portions of the aquifer with concentrations greater than non-detectable levels.
2. Mass estimates include mass of contaminants dissolved in groundwater and mass of contaminants sorbed to soil.

E.4 Extent of Contamination

The nature and extent of VOC contamination were estimated from a representative data set of VOCs collected primarily during or after 1992. This data set, and the rationale for selecting it, is presented in Chapter 4, Conceptual Model, of the Groundwater OU RI/FS (CH2M HILL, 1994). Groundwater contamination at the Base can be divided into three distinct contamination plumes that migrate from the original source area. These plumes are the OU A, OU B/C, and OU D plumes. The groundwater system has been divided into four layers: Monitoring Zones A, B, C, and D/E.

The plumes are presented in plan view in Figures 11, 12, 13, and 14 for the A, B, C, and D/E Zones, respectively.

Contamination in the OU A plume has been measured as deep as 225 feet bgs in a small area; contamination in the OU B/C plume has been measured as deep as 275 feet bgs. Although contamination has been detected in shallower Zone B OU D wells, contamination has consistently not been detected in the deepest OU D wells (screened as deep as 185 feet bgs in the B Zone). As a result of the operation of the six OU D extraction wells, contamination is not expected to exist below Zone B of OU D. The estimated vertical extent of contamination for the three plumes is presented in Figures 15, 16, and 17.

TCE is the most frequently detected and widespread contaminant.

The residential areas that may be affected by the offbase plume migration are presented in Figure 2. As discussed previously in Section B.2, History of Site Investigations and Interim Measures, municipal drinking water connections were offered to all residents in this area to reduce known exposure path ways between the contaminated groundwater and residents. The only migration pathway between the surface water and groundwater is through infiltration. Because the groundwater table is approximately 100 feet bgs, there is little to no possibility that surface water quality could be impacted by ground water contamination.

E.5 Summary of Data Gaps

Principal data gaps as of this writing are as follows:

- The extent of the deep plume beneath OUs B and C
- The extent of the plume moving offbase from OU B
- The extent of the southern OU A plume
- The extent of offbase contamination east of OU A
- The extent of contamination in OUs G and H
- The presence of contamination west of OU A and east of OU C (in the runway area)
- The presence of groundwater contamination in OUs E and F
- The extent of the low concentration plume west of OU C offbase
- The vertical extent and completeness of capture of the OU D plume
- The spatial distribution of aquifer parameters and lithology
- The need for metals removal and treatment
- The compatibility for treated water to be injected into the groundwater

F. Summary of Site Risks

A risk assessment was prepared during the RI/FS to support development of target volumes, as discussed in Section G.1, and to fulfill the NCP requirements for a baseline risk assessment. The baseline risk assessment provides risk managers with an understanding of actual and potential risks human health and the environment posed by Groundwater OU site contamination and any uncertainties associated with the assessment. This baseline risk assessment was developed using exposure scenarios that estimated the reasonable maximum exposure (RME). The RME is defined as the highest exposure that is reasonably expected to occur at a site. If a population is exposed by way of more than one pathway, the combination of exposures across pathways must also represent an RME. The elements of the risk assessment are as follows:

- Identification of contaminants of potential concern
- Exposure assessment
- Toxicity assessment
- Risk characterization

A complete presentation of the risk assessment is presented in the RI/FS, Appendix B, Risk Assessment Methodology.

This section summarizes the risks addressed by the groundwater response action and the rationale for implementing an interim action.

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F.1 Risks Addressed by the Groundwater Response Action

The risks to human health and the environment addressed by the groundwater remedy depend on the magnitude of the initial contaminant concentrations in the groundwater. Initial concentrations vary spatially, as do the corresponding initial risks. The current maximum potential risk magnitude is approximately one more cancer case per 100 people (10^{-2}) than would otherwise occur. This risk magnitude is calculated on the hypothetical basis of a human ingesting groundwater from one of the groundwater hot spots at McClellan AFB. As described in Section I of this document, the goal of the interim groundwater remedy is to contain and extract groundwater to MCLs. This goal corresponds to risk of 3.1 additional cancer cases per 1 million people (10-6) than would otherwise occur. This figure is calculated on the hypothetical basis of a human ingesting the groundwater that remains under McClellan AFB after the interim remedy has been completed. Cleanup of the hot spots to the containment goal of MCLs corresponds to a maximum potential risk reduction of 99.97 percent.

F.2 Rationale for the Implementation of an Interim Action

There are three major reasons for implementing an interim groundwater action now, rather than waiting for the full characterization of the extent of contamination and the establishment of mandatory cleanup levels:

- Data are adequate to show that some of the groundwater plumes under McClellan AFB are beginning to migrate beyond the McClellan AFB boundaries. In particular, plumes under OUs A, B, and C are moving toward potential water well users and need to be stopped. Implementation of a Basewide groundwater remedy is needed as soon as possible to stop the spread of these plumes.

- Implementing this groundwater remedy now will allow McClellan AFB more time to conduct treatability studies and basewide remedial investigations. These studies and investigations will benefit future Interim RODs and the final groundwater remedy for the Final ROD. For example, technologies proven successful during treatability studies will be incorporated into Basewide remedial actions. In addition, a better understanding of site conditions from remedial investigations will result in remedies that are designed to target specific areas.

- An additional objective of this remedy is to collect and analyze groundwater quality, groundwater flow, and other data during operation of the remedy to determine final in situ cleanup standards for the Groundwater OU. Among the critical decisions to be made are the extent to which, and the timeframe in which, to address lower levels of contamination that may remain in the aquifer after installation and initial operation of the remedy. The final ROD will include cleanup standards, which may differ for different portions of the OU, and may call for additional remedial actions. McClellan AFB expects that this interim remedy will provide the basis for the final remedy for the Groundwater OU.

G. Description of Alternatives

The FS for the Groundwater OU evaluated six remedial alternatives, as well as the No-Action Alternative. The six alternatives are similar in that they all represent some variation to

basic groundwater pump and treat technology. In addition, each is comprised of three components: a containment option, a treatment option, and an end-use option. Differences in the six alternatives stem from different combinations of these components.

This section first describes the options considered under each of the three components. Then it outlines how the components were assembled into six complete alternatives for evaluation in the FS.

After the public comment period, an additional alternative was assembled from the same components that were used to assemble the alternatives upon which the public commented. In addition, a feature of the end-use options was modified. These changes are considered logical outgrowths of the nine-criteria analysis and the response to comments that occurred during preparation of the Interim ROD.

G.1 Groundwater Containment Options

During the FS, the extent of VOC contamination was determined using available information. Target volumes were developed based on this extent of contamination, and containment strategies were developed to focus on these target volumes. By focusing on these areas, alternatives were generated to maximize containment, extraction, and treatment effectiveness.

Hence, three options for containment were developed focusing on the target volumes: containment of groundwater with contamination in excess of MCLs, containment of groundwater with contamination that exceeds a 10-6 cancer risk, and containment of groundwater with contamination above background. The containment option selected will determine the volume of aquifer that contains groundwater targeted for remedial action. These volumes are referred to as target volumes. Target volumes are volumes of aquifer, including the soil matrix and the pore space, which contain groundwater with contaminant concentrations greater than particular levels. Areal extents of these target volumes are based on concentration contours and risk contours of contaminant plumes. These target volumes, each of which corresponds to a containment option, are defined below:

- MCL Target Volume: The volume of aquifer with groundwater VOC concentrations greater than MCLs. Under federal drinking water standards, an MCL is the maximum permissible level that a contaminant in water can be delivered to any user of a public water system. (At McClellan AFB, the MCL target volume is about 1.2 billion cubic feet of groundwater.)

- 10-6 Cancer Risk Target Volume: The volume of aquifer with groundwater VOC concentrations such that if someone were to ingest the water over a lifetime, he or she would have an additional 1-in-1,000,000 chance of developing cancer. (At McClellan AFB, the 10-6 risk corresponds to about 2.1 billion cubic feet of groundwater, nearly double the MCL target volume.)

- Background Target Volume: All portions of the aquifer with contaminated groundwater. (At the Base, the background target volume is almost 4.6 billion cubic feet of groundwater, roughly double the 104 risk target volume.)

Illustrations of these three different target volumes in the A, B, and C Zones in plan view are provided in Figures 18, 19, and 20. The monitoring network in the D/E Zone is not extensive enough to delineate target volumes. The area each target volume covers is presented in Table 6, in both square feet and acres.

The MCL target volume is located within the 10-6 risk and the background target volume. The 10-6 risk target volume is located within the background target volume. The MCL target volume encompasses all the area within the MCL contour. The 10-6 risk target volume encompasses all the area within the 10-6 risk contour, including the MCL target volume. The background target volume encompasses all the area within the contour of VOCs >0.5 ,µg/l, including the MCL and 10-6 risk target volumes. The thicknesses of the target volumes in each of the zones are estimated to be the thicknesses of the monitoring zone that they are in. These depths are presented in Table 3. The quantitative volumes of the target volumes were calculated by using the areal extent of the target volumes and the thickness of the monitoring zones.

Table 6
Areal Extent of Target Volumes

	Target Volume							
	Hot Spot		MCL		Risk		Background	
Zone	acres	sq ft	acres	sq ft	acres	sq ft	acres	sq ft
A	25.84	1,125,588	663.92	28,922,385	966.45	42,101,564	1,570.29	68,406,331
B	0.00	0	100.87	4,394,208	187.90	8,185,615	474.40	20,666,275
C	0.00	0	52.28	2,277,387	127.84	5,568,954	306.28	13,342,400
Total	25.84	1,125,588	817.07	35,593,980	1,282.19	55,856,133	2,350.96	102,415,006

The three groundwater containment options include intensified extraction pumping and capture of the A Zone hot spots shown on Figure 18 (areas with groundwater VOC concentrations greater than or equal to 500 µg/l) to keep them isolated from the remainder of the plumes.

Approximate well numbers and flow requirements for each of these groundwater containment components are summarized in Table 7. These flow requirements are not the target volumes. They are the amount of extraction flow needed to contain the target volumes and to lower contaminant concentrations to specified cleanup levels. The volume of water extracted is not the target volume; as stated previously, the target volume is the volume of aquifer containing contaminant concentrations greater than a specified level. Table 7 was developed on the basis of FS-level analyses, as summarized in the Groundwater OU RI/FS. The actual number of wells and associated flows will be determined during remedial design and, in all likelihood, will deviate slightly from the estimates presented in Table 7.

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Table 7
Number of Extraction Wells and Flow Rates Required to Contain Different Target Volumes

	Monitoring Zone							
	A		B		C		Total	
Target Volumes	No. Wells	Q (gpm)	No. Wells	Q (gpm)	No. Wells	Q (gpm)	No. Wells	Q (gpm)
Background Target Volume	141	1,130	34	470	20	410	195	2,010
Risk Target Volume	106	810	31	420	9	180	146	1,410
MCL Target Volume	91	650	26	330	5	100	122	1,080

As expected, extraction well requirements are largest for the background target volume and smallest for the MCL target volume. Total flow requirements range from roughly 1,000 to 2,000 gpm, depending on the selected target volume. Present worth, capital, and operations and maintenance (O&M) costs for each containment option are addressed in Section H.7.

G.2 Groundwater Treatment Options

The treatment system consists of an existing west side treatment plant and a new treatment plant, if needed, on the east side of the Base. Groundwater extracted from underneath OUs B, C, and D will be piped to the GWTP, while groundwater under OU A will be piped to the new east side treatment plant, if required. The existing west side plant will be evaluated to determine if it can handle increased flow capacity and changes in influent concentrations. If a new east side treatment plant is needed, it will be designed with standard treatment technologies. This section presents the groundwater treatment options that were evaluated in detail in the FS; the implementation plans for these options; uncertainties and contingencies incorporated into the plans; and the estimated present worth, capital, and O&M Costs.

G.2.1 Expansion of the West Side Treatment Plant

The west side treatment plant was originally designed in 1986 to treat 1,000 gpm. Several modifications have taken place, mostly in response to lower-than-planned flows, leaving the plant at a current capacity of 750 gpm. The plant can be expanded to match the eventual flow from the extraction wells on the west side of the Base. The west side treatment plant capacity will be expanded if the flow from the west plumes exceeds 750 gpm. Hence, if the 10-6 risk or background target volume were selected, the west side treatment plant would be expanded. The west side treatment plant system is currently composed of an air stripper (AS) with thermal oxidation to treat offgas and liquid-phase granular activated carbon and (LGAC) for polishing.

G.2.2 Treatment Options for the East Side Treatment Plant

Five groundwater treatment options and three offgas treatment technologies were presented during the FS for the new east side groundwater treatment plant, if one were required. These eight options were assembled into eleven treatment trains. These treatment trains were evaluated based on four criteria robustness, implementability, effectiveness, and cost. Based on the FS evaluation, three treatment trains were selected as options for the treatment component of the remedy. This screening precess is presented in Figure 21.

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The three treatment options presented in Figure 21 have been considered for the new east side ground water treatment plant

- LGAC to treat influent groundwater
- AS to treat influent groundwater and catalytic oxidation (CatOx) to treat offgas
- AS to treat influent groundwater and vapor-phase granular activated carbon (VGAC) to treat offgas

Air stripping technology releases a residual gas stream that must be treated LGAC does not release a gas stream.

Each of the three treatment options is summarized below. The typical layout of these technologies presented in Figure 22. The costs and uncertainties associated with these technologies will be presented further in this Interim ROD.

Liquid-Phase Granular Activated Carbon. Carbon is used for groundwater treatment to remove a wide variety of chemicals, including VOCs. This technology works through adsorption of the contaminants onto the carbon. For most VOCs, a carbon bed will provide a high (greater than 95 percent) removal of compounds until it is saturated or loaded with contaminants.

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Typically, two carbon beds will be used in series. The first bed will be online until it is fully loaded, allowing the second bed to catch the breakthrough contaminants before final discharge. When a bed is loaded, carbon vendors are employed to remove the spent carbon and refill the bed. The spent carbon is thermally regenerated at a vendor facility offbase. Equipment required consists of aboveground skid-mounted tanks that contain the carbon beds and pumps. The only residual generated is the spent carbon, which is treated by a vendor. If the spent carbon meets hazardous waste criteria, Mclellan AFB will ensure that the waste is treated at a legally permitted facility.

Air Stripping with Catalytic Oxidation. Air stripping uses a tower to contact groundwater flowing downward with air flowing upward. Packing is used to break the groundwater stream into small droplets in the tower and enhance air-groundwater contact. As a result of this contact, VOCs transfer from the groundwater to the gas and exit the tower in an offgas stream. Air stripping equipment required includes the tower (approximately 40 feet tall), an air blower, and pumps. Residuals generated include the offgas, which will be treated using catalytic oxidation before discharging to the atmosphere. Treated water may require carbon polishing, depending on end use.

Catalytic oxidation offgas treatment technology oxidizes VOCs in the AS offgas by heating the offgas and passing it through a catalyst bed, which enhances the oxidation of VOCs to nontoxic water vapor, carbon dioxide, and hydrochloric acid (HCI). HCI can be removed, if it is present in significant amounts, with a separate scrubber. Equipment required includes a packaged oxidizer system and stack. If scrubbing is required, sodium hydroxide storage. delivery, and distribution systems are required. Residuals include HCI, which is present in the offgas. Air stripper offgas streams usually do not contain HCI concentrations high enough to require treatment before discharge following a CatOx unit.

Air Stripping with Vapor-Phase Granular Activated Carbon. This option uses the same air stripping technology described previously. The difference is that carbon is used to treat the AS gas. The adsorption mechanism for airborne VOCs is similar to that described above for LGAC. In gas-phase adsoption, water vapor in the gas stream adversely affects VOC adsorption. Duct heaters are used to raise the temperature of the offgas to lower the relative humidity of the offgas to enhance VOC adsorption in the fiberglass vessels that house the carbon beds and a stack. Residuals include the carbon, which is regenerated offsite. As with LGAC, if the spent carbon falls within the definition of hazardous waste, it will be treated at a legally permitted facility.

G.2.3 Uncertainties in Influent Parameters

Several uncertainties regarding groundwater system responses could affect the performance of the treatment process and should be addressed before a standard technology is selected. The principle uncertainties identified in the Groundwater OU RI/FS include:

- The extent of contamination
- The response of the groundwater system to remedial extraction
- Influent flows and concentrations. The design of the treatment system should be based on influent flow rates and concentrations. Therefore, the prospective new east side treatment plant cannot be designed and the west side treatment plant cannot be evaluated until uncertainties regarding the groundwater system are sufficiently reduced. Uncertainty can be reduced during the remedy by sequencing projects and activities that address the unknowns. These activities include investigating further the extent of contamination, performing aquifer tests, and determining metals concentrations in groundwater and impacts of Base activities on metals contamination. These activities are discussed further in Section I.

Metals in the groundwater will be investigated as a remedial design activity. Metals concentrations in groundwater extracted over a long period of time will be evaluated to determine if metals removal is necessary during treatment; concentrations may be greater than the discharge limits for the end uses and may need to be treated. If metals removal is needed, the treatment system will either be modified or a contingency plan will be prepared to treat metals in extracted groundwater.

G.3 End-Use Options

The following four end-use options were carried forward from an initial screening performed during the Contaminated Groundwater Cleanup Workshop on August 10, 1993:

- Discharge to McClellan AFB's existing greywater conveyance system
- Discharge to Magpie Creek
- Selling to neighboring water districts
- Onbase injection to deeper aquifers

These four end-use options have been assembled into two end-use options for treated groundwater. They are described below. These end-use options contain similar elements and therefore are not mutually exclusive. They are also both implementable. The layouts of these two options are presented in Figure 23.

End-Use Option 1

End-Use Option 1 would convey as much treated groundwater as possible to McClellan AFB's existing greywater system. The remaining flow would be sold to neighboring water districts. McClellan AFB currently uses some water from the existing west side treatment unit in a greywater system The greywater system consists of a 250,000 gallon storage tank, a pressurizing pump system near the existing groundwater treatment unit, and a network of piping to cooling towers and Magpie Creek. The greywater system uses the water in cooling towers. The greywater system is currently being inspected and tested to determine its water needs. It may be expanded to serve a greater part of the Base. Current estimates indicate that the greywater system could reuse as much as 700 gpm of the treated groundwater. Because of greywater connections already located at that site, initially only water from the west side treatment unit will be used for the greywater system. If an east side treatment plant needs to be built, treated groundwater from this plant will be sent to a separate east side greywater system.

Purveyors that have expressed an interest in the treated groundwater and that have facilities nearby include Northridge Water District and Arcade Water District on the east, and Rio Linda Water District on the west. Northridge Water District has two existing service connections in the vicinity of the proposed east treatment unit. Arcade Water District has facilities further north of the proposed east side treatment unit. Rio Linda Water District has facilities in the vicinity of the west side treatment unit. This analysis assumes that up to 650 gpm will be supplied to Northridge Water District and up to 1,600 gpm to Rio Linda Water District. No storage is required because the demand from both districts is much greater than the discharge flow rates.

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Because water from the treatment plant will be treated to standards that are at least as stringent as those required by the federal Safe Drinking Water Act, McClellan AFB recognizes that any end-use other than utilization as drinking water could be perceived as a waste of a valuable resource. For this reason, McClellan AFB is continuing to explore with Cal-EPA, U.S. EPA , and surrounding communities how best to utilize the treated water, including providing it to neighboring water districts.

In the event of maintenance requirements, which may occur only once or twice a year, the backup system would discharge the treated groundwater to Magpie Creek. Throughout much of McClellan AFB, Magpie Creek is a concrete-lined canal. Because the canal's existing design capacity is 700 cfs, or approximately 314,000 gpm, the additional flows from the treatment plant will not adversely impact the flow capacity of the creek. The existing groundwater treatment plant already discharges its water into Magpie Creek.

End-Use Option 2

End-Use Option 2 would reuse as much of the treated groundwater in McClellan AFB''s existing greywater system as possible. As stated previously, the greywater system is currently being inspected to determine its water needs.

The remaining flow either would be discharged into Magpie Creek or injected into the

groundwater. Preference will be to discharge to Magpie Creek, but injection will be re-evaluated if Magpie Creek cannot handle the flow. For much of the year, Magpie Creek is dry (except for discharge from the existing GWTP). During winter storms, Magpie Creek occasionally overflows. When the remedy is in full operation, discharge from the GWTP will represent less than one-half of 1 percent of the creek's capacity. NPDES substantive requirements regarding discharge limits will have to be met.

If the greywater system and Magpie Creek cannot accommodate all the treated groundwater flow, injection of treated groundwater into wells at the north end of McClellan AFB would be re-evaluated. Injection was originally evaluated in the FS. The north site was chosen because of its distance from any known groundwater contamination. Treated groundwater from the east side and west side treatment units would be injected into the wells.

For this end-use, it has been assumed that water could be injected approximately 600 feet bgs and that as many as four injection wells would be required. One injection well would be a standby well for maintenance purposes. Injection pilot tests will determine how much flow potentially could be injected into the selected aquifers. Injection costs and capacity have been estimated under the assumption that the inorganic water qualities of the treated water would be similar to those of the aquifers where injection would take place.

G.4 Applicable or Relevant and Appropriate Requirements

Section 121(d) of CERCLA states that remedial actions on CERCLA sites must attain (or the decision document justify the waiver of) any federal or more stringent state environmental standards, requirements, criteria, or limitations that are determined to be legally applicable or relevant and appropriate (ARAR). Applicable requirements are those cleanup standards, criteria, or limitations promulgated under federal or state law that specifically address the situation at a CERCLA site. A requirement is applicable if the jurisdictional prerequisites of the environmental standard show a direct correspondence when objectively compared with the conditions at the site.

If a requirement is not legally applicable, the requirement is evaluated to determine whether it is relevant and appropriate. Relevant and appropriate requirements are those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not applicable, address problems or situations sufficiently similar to the circumstances of the proposed response action and are well-suited to the conditions of the site. The criteria for determining relevance and appropriateness are listed in Title 40, Code of Federal Regulations, Section §300.400(g)(2) (40 CFR §300.400(g)(2)).

ARARs are concerned only with substantive, not administrative, requirements of a statute or regulation. The substantive portions of the regulation are those requirements that pertain directly to actions or conditions in the environment. Examples of substantive requirements include quantitative health- or risk-based restrictions upon exposure to types of hazardous substances (e.g., MCLs). Administrative requirements are the mechanisms that facilitate implementation of the substantive requirements. Administrative requirements include issuance of permits, documentation, reporting, recordkeeping, and enforcement. Thus, in determining the extent to which onsite CERCLA response actions must comply with environmental laws, a distinction should be made between substantive requirements, which may be ARARs, and administrative requirements, which are not.

Furthermore, the ARARs provision in CERCLA applies to onsite actions. "Onsite" is defined as the areal extent of contamination and includes the groundwater plumes to be remediated. According to CERCLA §121(e), a remedial response action at takes place entirely onsite may proceed without the obtaining of permits. This permit exemption applies to all administrative requirements, as well as to permits. Actions taken offsite will need to comply with the substantive as well as the administrative requirements of all applicable regulations.

Pursuant to EPA guidance, ARARs generally are classified into three categories: chemical-specific, location-specific, and action-specific requirements. This classification was developed to help identify ARARs, some of which do not fall precisely into one group or another. These categories of ARARs are defined below:

- Chemical-Specific ARARs include those laws and requirements that regulate the release to the environment of materials possessing certain chemical or physical characteristics or containing specified chemical compounds. These requirements generally set health- or risk-based concentration limits or discharge limitations for specific hazardous substances. If, in a specific situation, a chemical is subject to more than one discharge or exposure limit, the more stringent of the requirements should generally be applied.

- Location-Specific ARARs are those requirements that relate to the geographical or physical position of the site, rather than the nature of the contaminants or the proposed site remedial actions. These requirements may limit the placement of remedial action, and may impose additional constraints on the cleanup action.

- Action-Specific ARARs are requirements that define acceptable handling, treatment, and disposal procedures for hazardous substances. These ARARs generally set performance, design, or other similar action-specific controls or restrictions on particular kinds of activities related to management of hazardous substances or pollutants. These requirements are triggered by the particular remedial activities that are selected to accomplish a remedy. Because a remedial site usually involves several alternative actions, very different action-specific requirements can apply.

G.4.1 Chemical-Specific ARARs

Table 8 lists the federal and state chemical-specific ARARs for the selected alternative. A brief description of how the ARAR is applied to the alternative is also provided.

G.4.2 Location-Specific ARARs

Federal and state location-specific ARARs for the selected alternative are presented in Table 9. These ARARs may limit the placement or affect implementation of the remedial action because of the physical or geographical position of the Base. A brief description of how the ARAR is applied to the alternative is also provided.

Table 8
Chemical Specific ARARs for the
Groundwater OU IROD

Requirement	Description of Requirement
Federal Chemical-Specific ARARs	
Safe Drinking Water Acta	
40 CFR §141, Subparts B and G (See Table 4 for MCLs)	National primary drinking water standards are health-based standards for public water systems (maximum contaminant levels [MCLs]). The National Contingency Plan (NCP) defines MCLs as relevant and appropriate for groundwater determined to be a current or a potential source of drinking water in cases where maximum contaminant level goals (MCLGs) are not ARARs. Groundwater in the vicinity of McClellan AFB has been designated for drinking water use. Groundwater in the Groundwater OU with contaminant concentrations above MCLs will be contained.
40 CFR §141 Subpart F	MCLGs that have non-zero values are relevant and appropriate for groundwater determined to be a current or a potential source of drinking water (40 CFR 300.430(e)(2)(i)(B) through (D)). Groundwater in the vicinity of McClellan AFB has been designated for drinking water use. Non-zero MCLGs exist for some of the chemicals of potential concern; therefore, groundwater with contaminant concentrations above non-zero MCLGs will be contained.
Clean Water Act (CWA)a	
33 USC §1313 and 40 CFR §131.36	Water quality standards are applicable to remedial actions that could impact surface water, such as Magpie Creek.
State Chemical-Specific ARARs	
Cal-EPA Department of Toxic Substances Control (DTSC)a	
22 CCR §64435 and 64444.5	Like federal MCLs, state MCLs are tap standards that are relevant and appropriate for the aquifer at McClellan AFB that is or may be used as a drinking water source. State MCLs are relevant and appropriate only if they are more stringent than the federal MCLs.

Table 8
Chemical-Specific ARARs for the
Groundwater OU IROD

Requirement	Description of Requirement
State and Regional Water Quality Control Board (RWQCB)a	
Water Quality Control Plan (Basin Plan) for the Central Valley Region. Specific applicable sections include designated beneficial uses of affected water bodies, and numerical and narrative water quality objectives.	Beneficial uses of the groundwater in the vicinity of McClellan AFB, as identified in the Basin Plan, include agricultural, municipal, industrial, and domestic water supply. The water quality objectives, including narrative and numerical standards, are applicable to the groundwater and to affected surface waters. These objectives and standards need to be met to protect the beneficial uses.

aThe specific ARAR citation is listed below the general heading. Only the substantive requirements are considered ARARs.

Table 9
Location-Specific ARARs for the
Groundwater OU IROD

Requirement	Description of Requirement
Federal Location-Specific ARARs	
Endangered Species Act of 1973a	
16 USC §1536(a)	This requirement is applicable because endangered species have been identified at the Base, the effects that the remedial action may have on these species will need to be determined. Actions may need to be taken to conserve endangered species or threatened species, including consultation with the Department of the Interior, Fish and Wildlife Service. Proposed endangered species that have been identified at the Base include the California Linderiella and the Vernal Pool Fairy Shrimp.
Clean Water Acta	
40 CFR §231.10	The Clean Water Act prohibits discharge of dredged or fill material (i.e., bank material that may fall into creeks) into surface water. This requirement is applicable to construction activities that may affect creeks at the Base.
State Location-Specific ARARs	
California Department of Fish and Game Code	
California Endangered Species Act, Fish and Game Code §2050, et seq.	Because endangered species have been identified at the Base, this requirement is applicable. The effects that the remedial action may have on these species will need to be determined. California Species of Special Concern identified at the Base include the Burrowing Owl and the Loggerhead Strike.

aThe specific ARAR citation is listed below the general heading. Only the substantive requirements are considered ARARs.

G.4.3 Action-Specific ARARs

The federal and state action-specific ARARs for the selected remedy are presented in Table 10. In some cases, the regulations cited under the federal ARARs are state regulations because, for the purposes of ARARs analysis, state regulations that are a component of a federally authorized or delegated state program are generally considered to be federal requirements and potential federal ARARs (55 Federal Register 8742). Because U.S. EPA has authorized the California RCRA program, the regulations found in Division 4.5 Title 22 CCR are a source of potential federal ARARs for CERCLA response actions, including this Groundwater OU.

These ARARs generally set performance, design, or other similar action-specific controls or restrictions on certain activities related to management of hazardous substances or pollutants.

G.5 Assembled Alternatives

The containment, treatment, and end-use systems described in Sections G.1 through G.3 were combined to form seven alternatives. Although various combinations of the three target volumes, the three treatment technologies, and the two end-use systems do exist, seven likely alternatives were evaluated. They are summarized in Table 11 and described in the following paragraphs. The alternatives described here, and the priorities for implementing the remedy listed in Section I.3, are based on current information. Logistics and priorities for implementing the selected alternative may change as new data are collected.

Table 10
Action-Specific ARARs for the
Groundwater OU IROD

Requirement	Description of Requirement
Federal Action-Specific ARARs	
Resource Conservation and Recovery Act (RCRA)a	
22 CCR §66262.10(a), §66262.11, and §6626234	Requirements for the identification and accumulation of hazardous waste are applicable to hazardous wastes (i.e., contaminated soil cuttings and extracted underwater) generated during implementation of the remedial alternative.
22 CCR §66264.171, 172, 173, 174, 175(a) and (b), 175, 177, and 178	Requirements for storage of hazardous waste held for a period greater than 90 days before treatment, disposal or storage elsewhere, in a container, are applicable to hazardous wastes (i.e., contaminated soil cuttings and extracted groundwater) generated during implementation of the remedial alternative.
Substantive requirements of 22 CCR §66264.601	Design and operating standards for miscellaneous units that treat hazardous waste are relevant and appropriate to air strippers.
22 CCR §66264.96, §66264.97(b)(1)(D), (b)(2), (b)(4) through (7), §66264.99	General water quality monitoring and system requirements are relevant and appropriate because wastes that have been discharged to land (source areas) are causing groundwater contamination. The monitoring program will evaluate the effectiveness of the groundwater corrective action.
Substantive requirements of 22 CCR §66264.100, with the exception to references made to groundwater protection standards	Requirements for the implementation of corrective action measures are relevant and appropriate because wastes that have been discharged to land (source areas) are causing groundwater contamination. Corrective act on shall include water quality monitoring to demonstrate the effectiveness of the corrective action.

Table 10
Action-Specific ARARs for the
Groundwater OU IROD

Requirement	Description of Requirement
40 CFR §144.12(a)(e) and §144.13	The underground injection control (UIC) program prohibits injection activities that allow movement of contaminants into underground sources of drinking water that may result in violations of MCLs or adversely affect health. The UIC program regulates construction of Class IV wells. These requirements are applicable to groundwater injection wells that may be constructed as part of the remedial action. §144.13 provides that treated groundwater may be injected into the same formation if such injection is approved under CERCLA cleanup provisions.
Clean Air Acta	
SMAQMD Rule 202	Emissions from a new groundwater treatment plant must comply with new source review regulations. BACT requirements are applicable to treatment plant emissions.
SMAQMD Rule 402 (as promulgated)	Emissions from a new groundwater treatment plant may not cause injury, detriment, nuisance, or annoyance to the public, businesses, or property.
SMAQMD Rule 403	Fugitive dust control standards must be met within the areal extent of contamination during any construction activities as a result of implementing the groundwater remedial action.
State Action-Specific ARARsa	
State Water Resources Control Board Resolution No. 68-16	This resolution requires that quality of waters of the State that is better than needed to protect beneficial uses be maintained. Discharges to high quality waters must be treated using best practicable treatment, Beneficial uses must be protected. These requirements are applicable to discharges of treatment plant effluent to Magpie Creek or injection into clean aquifers.
23 CCR §2510(g)	Groundwater monitoring may be required if wastes that were discharged to waste management units at McClellan AFB prior to November 27, 1984 threaten groundwater quality. If a known release has occurred, the corrective action requirements in 22 CCR §66264.100 will be relevant and appropriate.

aThe specific ARAR citation is listed below the general heading. Only the substantive requirements are considered ARARs.

Table 11
Alternatives for Groundwater at McClellan AFB

	Extraction Target Volume	Extraction Flow Rate (gpm)		Treatment Systema		End-Use Systemb
Alternative	Basewide	East	West	East	West	Basewide
1	MCL	460	630	AS/CatOx/LGAC	GWTP	Option 2
2	10-6 Cancer Risk	590	820	AS/CatOx/LGAC	GWTP (w/expansion)	Option 2
3	Background	710	1,300	AS/CatOx/LGAC	GWTP (w/expansion)	Option 2
4	10-6 Cancer Risk	590	820	AS/VGAC/LGAC	GWTP (w/expansion)	Option 2
4A	MCL	460	630	AS/VGAC/LGAC	GWTP	Option 2
5	10-6 Cancer Risk	590	820	AS/CatOx/LGAC	GWTP (w/expansion)	Option 1
6	10-6 Cancer Risk	590	820	LGAC	GWTP (w/expansion)	Option 2

aTreatment System Definitions: AS = Air Stripping; CatOx = Catalytic Oxidation Off, gas Treatment; LGAC = Liquid-Phase Granular Activated Carbon; and VGAC = Vapor-Phase Granular Activated Carbon Offgas Treatment.
bEnd-Use System Definitions: Option 1 = Greywater (primary); Water Districts (secondary); and Magpie Creek (backup). Option 2 = Greywater (primary); Magpie Creek (secondary); and injection (backup and contingency).

Alternative 1

Alternative 1 consists of extracting groundwater from the MCL target volume. Groundwater from OU B, OU C, and OU D would be piped to the existing west side treatment plant. Groundwater from OU A would be piped to a new east side treatment plant, if needed. This new east side treatment plant would use AS to treat groundwater, LGAC to polish the treated groundwater, and CatOx to treat the residual offgas from the air stepper. As much treated water as possible from the west and east side treatment plants would be used in McClellan AFB's greywater system. The remainder of the treated water from both plants would be discharged into Magpie Creek and or injected into the groundwater. The portion of water to be injected into the groundwater or discharged into Magpie Creek is dependent on the capacity of the greywater system.

Alternative 2

Alternative 2 consists of extracting groundwater from the 10-6 Cancer Risk target volume. Groundwater from OU B, OU C, and OU D would be piped to the existing west side treatment plant (which may need to be expanded to treat higher flow rates). Groundwater from OU A would be piped to a new east side treatment plant, if needed. This new east side treatment plant would use AS to treat groundwater, CatOx to treat the residual offgas from the air stripper, and LGAC to polish the treated groundwater. As much treated water as possible from the west and east side treatment plants would be used in McClellan AFB's greywater system. The remainder of the treated water from both plants would be discharged into Magpie Creek and/or injected into the groundwater. The portion of water to be discharged or injected into Magpie Creek is dependent on the capacity of the greywater system.

Alternative 3

Alternative 3 consists of extracting groundwater from the background target volume. Groundwater from OU B, OU C, and OU D would be piped to the existing west side treatment plant, which may need to be expanded to accommodate higher flows. Groundwater from OU A would be piped to a new east side treatment plant, if needed. This new east side treatment plant would use AS to treat groundwater, LGAC to polish the treated groundwater, and CatOx to treat the residual offgas from the air stripper. As much treated water as possible from the west and east side treatment plants would be used in McClellan AFB's greywater system. The remainder of the treated water from both plants would be discharged into Magpie Creek and/or injected into the groundwater. The portion of water to be injected or discharged into the groundwater into Magpie Creek is dependent on the capacity of the greywater system.

Alternative 4

Alternative 4 consists of extracting groundwater from the 10-6 Cancer Risk target volume. Ground water from OU B, OU C, and OU D would be piped to the existing west side treatment plant, which may need to be expanded to accommodate higher flows. Groundwater from OU A would be piped to a new east side treatment plant, if needed. This new east side treatment plant would use AS to treat groundwater, LGAC to polish the treated groundwater, and VGAC to treat the residual offgas from the air stripper. As much treated water as possible from the west and east side treatment plants would be used in McClellan AFB's greywater system. The remainder of the treated water from both plants would be discharged into Magpie Creek and/or injected into the groundwater. The portion of water to be injected into the groundwater or discharged into Magpie Creek is dependent on the capacity of the greywater system.

Alternative 4A

Alternative 4A consists of extracting groundwater from the MCL target volume. Groundwater from OU B, OU C, and OU D would be piped to the existing west side treatment plant. Groundwater from OU A would be piped to the existing west side treatment plant or, if necessary, to a new east side treatment plant, depending on cost-effectiveness. This new east side treatment plant would use AS to treat groundwater, LGAC to polish the treated groundwater, and VGAC to treat the residual offgas from the air stripper. As much treated water as possible from the west and east side treatment plants would be used in McClellan AFB's greywater system. The remainder of the treated water from both plants would be discharged into Magpie Creek and/or injected into the groundwater. The portion of water to be injected into the groundwater or discharged into Magpie Creek is dependent on the capacity of the greywater system.

Alternative 5

Alternative 5 consists of extracting groundwater from the 10 Cancer Risk target volume. Ground water from OU B, OU C, and OU D would be piped to the existing west side treatment plant, which may need to be expanded to accommodate higher flows. Groundwater from OU A would be piped to a new east side treatment plant, if needed. This new east side treatment plant would use AS to treat groundwater, LGAC to polish the treated groundwater, and CatOx to treat the residual offgas from the air stripper. As much treated water as possible from the west and east side treatment plants would be used in McClellan AFB's greywater system. The remainder of the treated water from both plants will be provided to neighboring water districts. In the event of maintenance requirements, treated water would be discharged to Magpie Creek.

Alternative 6

Alternative 6 consists of extracting groundwater from the 10-6 Cancer Risk target volume. Groundwater from OU B, OU C, and OU D would be piped to the existing west side treatment plant, which may need to be expanded to accommodate higher flows. Groundwater from OU A would be piped to a new east side treatment plant, if needed. This new east side treatment plant would use LGAC to treat and polish the groundwater. There would be no residual emissions; therefore, offgas treatment would not be needed. As much treated water as possible from the west and east side treatment plants would be used in McClellan AFB's greywater system. The remainder of the treated water from both plants would be discharged into Magpie Creek and/or injected into the groundwater. The portion of water to be discharged into Magpie Creek or injected is dependent on the capacity of the greywater system.

H. Summary of the Comparative Analysis of Alternatives

Each of the above-mentioned alternatives was evaluated against nine criteria recommended by the EPA in guidance documentation for conducting RI/FS work. The evaluation criteria are grouped such that two are threshold criteria, which any alternative must meet; five are comparison criteria, which allow the alternatives to be compared against each other, and two are acceptance criteria, which will be addressed after receiving public comments. These are the minimum criteria recommended by the EPA. A comparison of the No-Action Alternative and the seven assembled alternatives, using the nine EPA criteria, is presented in Table 12.

Table 12: Comparison of Alternative Against Nine EPA Criteria

Criteria Description	Alternative							
	No Action	1	2	3	4	4A	5	6
Threshold Criteria								
1. Overall Protection of Human Health and Environment	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
2. Compliance with ARARs	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Comparison Criteria	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
3. Long-term Effectiveness and Permanence	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4. Reduction of Toxicity, Mobility, and Volume through Treatment	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
5. Short-term Effectiveness	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes
6. Implementability	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
7. Cost (Present Worth)a	N/Ab	$54,900,000	$66,100,000	$81,000,000	$66,000,000	$57,200,000	$70,100,000	$74,000,000

Table 12: Comparison of Alternative Against Nine EPA Criteria

Criteria Description	Alternative							
	No Action	1	2	3	4	4A	5	6
Acceptance Criteria								
8. State Acceptance	No	Yes	Yes	Yes	Yes	Yes	Yesc	Yes
9. Community Acceptance	No	Yes	Yes	Yes	Yes	Yes	Yesd	Yes

Assumptions:

aInterest Rate = 5 percent Analysis Period = 20 years
bThe Air Force has spent approximately $10 million on construction and operation of voluntary groundwater remedial actions.
cThe State of California concurs with all aspects of the alternative, except it has reservations about providing treated groundwater to neighboring water districts.
dBased on acceptance of June 1994 Proposed Plan and December 1994 Fact Sheet; if McClellan deviates from the end use presented to the public, McClellan will provide public notice.

H.1 Overall Protection of Human Health and the Environment

The No-Action Alternative will not adequately protect human health and the environment. While there are no significant risks to human health or the environment under current conditions, groundwater contaminants within OUs A, B, and C are not contained and have the potential to migrate offbase and impact offbase municipal or supply wells.

Alternatives 1 through 6 would protect human health and the environment by containing contaminated groundwater and preventing future migration offbase. Alternative 3 would offer the greatest level of protection from potential exposure to contaminated groundwater because it extends containment to background levels. Contaminant to background leaves a residual level of increased cancer risk of 3.1 x 10-7. Alternatives 2, 4, 5, and 6 would provide equal levels of protection from exposure to contaminated groundwater because they contain contamination to the level that could cause no more than a residual level of increased cancer risk of 10-6. Alternatives 1 and 4A would be the least protective of the alternatives in terms of containing the groundwater contamination, but still meet the MCL requirements for drinking water. Containment to MCLs leaves 2 residual level of increased cancer risk of 3.1 x 10-6.

The National Contingency Plan (NCP), however, expects risks achieved from remedial actions to fall between 10-6 and 10-4. Hence, the residual risks from all alternatives, including Alternatives 1 and 4A, fall within or below the NCP range.

Water and air treatment systems for all of the alternatives are equally protective. End-use options are also equally protective because the groundwater will be treated to levels that meet or exceed the treatment levels required by RWQCB and California Department of Health Services/Office of Drinking Water (DHS/ODW).

H.2 Compliance with ARARs

The No-Action Alternative is not adequate to meet ARARs or to fully remove the possibility of future contaminant exposure to public water supplies. Concentrations of groundwater contaminants exceed allowable levels under state and federal requirements. The OU D capture zone is adequate for the contamination within the OU D hot spot, but the OU B/C plume and the OU A plume are not fully contained by the existing systems.

Table 13 summarizes how Alternatives 1 through 6 comply with the ARARs. All of the alternatives meet MCLs under the Safe Drinking Water Act. Treated water would achieve discharge requirements under the Clean Water Act and the State Water Resources Control Board ARARs.

Table 13
Compliance with ARARsa

Alternative	No Action	1	2	3	4	4A	5	6
Containment Option								
Meets Safe Drinking Water Act Criteria (MCLs)		✓		✓	✓	✓	✓	✓
Treatment Option								
Meets SMAQMD Rule 202, New Source Review-With Base Action to Offset NOx or Reactive Organic Gases (ROGs). BACT will be applied to meet this requirement	✓	✓	✓	✓	✓	✓	✓	N/A
Meets RCRA Requirements for Storage, Closure, Corrective Action, Groundwater Monitoring, and Treatment of Hazardous Waste		✓	✓	✓	✓	✓	✓	✓
Meets the Location-Specific ARARs for the Protection of Endangered Species	✓	✓	✓	✓	✓	✓	✓	✓
End-Use Option								
Meets SWRCB Resolution 68-16	✓	✓c	✓c	✓c	✓c	✓c	✓c	✓c
Meets CWA Discharge Requirements	✓	✓b	✓b	✓b	✓b	✓b	✓b	✓b
Meets Numerical and Narrative Water Quality Objectives in the Water Quality Control Plan for the Central Valley Region	✓b	✓b	✓b	✓b	✓b	✓b	✓b	
Meets the Location-Specific ARARs for the Protection of Endangered Species	✓	✓	✓	✓	✓	✓	✓	✓
Meets the Fish and Game Requirements for Alteration of Streambeds	✓	✓	✓	✓b	✓b	✓b	✓b	✓b
Meets the Underground Injection Control (UIC) Requirements	N/A	✓	✓	✓	✓	✓	N/A	✓

aSpecific citations for the ARARs listed above are provided in Section G.4.
bThis ARAR applies only to discharges to Magpie Creek as a contingency.
cThis ARAR applies to discharges to Magpie Creek and/or injection to the groundwater as a contingency.

Alternatives 1, 2, 3, and 5 would use air stripping with CatOx for offgas control from air stripping towers. These alternatives are subject to ARARs limiting acceptable NOx discharges and requiring BACT for offgas control on new emission sources. Currently, McClellan AFB is not permitted to BACT for offgas control on new emission sources. Currently, McClellan AFB is not permitted to discharge additional amounts of NOx. These alternatives potentially would meet SMAQMD rules for new source review if McClellan AFB would offset NOx emissions from other sources within the Base or would purchase NOx credits.

Alternatives 4 and 4A would use vapor-phase carbon for offgas control in the new east side treatment plant, if the new plant is needed. This option is expected to allow slight VOC emissions into the air, but will not create NOx or SOx. This technology has been considered BACT. Removal efficiencies are expected to be in the range of 95 to 99 percent for most compounds in stripper offgas. Methylene chloride and vinyl chloride, which have relatively limited extent in groundwater, would not be efficiently controlled by vapor-phase carbon. Generally, offgas concentrations would be low or nondetect, with occasional transient peaks. Of all the alternatives that release air emissions, Alternatives 4 and 4A would most easily comply with ARARs for air emissions because they do not emit NOx.

Alternative 6 does not have air emissions. Hence SMAQMD rules are not applicable.

The existing GWTP is currently operating under substantive requirements for water and air discharge. These discharge limitations were initially given based on water flow rates of 1,000 gpm. Alternatives 2, 3, 4, 5, and 6 require expansion of the existing GWTP to greater than 1,000 gpm. Compliance with ARARs would be readily achievable for Alternatives 2, 3, 4, 5, and 6.

H.3 Long-Term Effectiveness and Permanence

This criterion applies to all alternatives. It is applied to each alternative in terms of the risk remaining at the site after the response objectives have been met; that is, after concentrations of contaminants in the target volumes have been reduced to the target concentrations (MCL, 10-6 cancer risk, or background). The primary focus of this evaluation is the extent and effectiveness of controls that may be required at the conclusion of remedial activities. The effectiveness can be measured by remaining residual risk, risk reduction, mass removal, and volume of contaminated groundwater that exist. These measurements are depicted on figure 24.

The No-Action Alternative is not effective in the long-term because containment of hot spots in OUs A, B, and C is not achieved, and contamination may migrate offsite from these areas.

Alternatives 1 and 4A contain and treat contaminants in the MCL target volume. These alternatives provide 99.97 percent risk reduction and leave a residual risk of 3.1 x 10-6. About 20,500 pounds (9,300 kg) of VOCs would be extracted within the approximately 1.25 billion cubic feet of contaminated groundwater.

Alternatives 2, 4, 5, and 6 contain and treat contaminants in the 10-6 risk target volume. These alternatives provide 99.98 percent risk reduction and leave a residual risk of 1 x 10-6. About 20,700 pounds (9,400 kg) of VOCs would be extracted within the approximately 2.1 billion cubic feet of contaminated ground water.

Alternative 3 contains and treats contaminants in the background target volume. Alternative 3 provides 99.99 percent risk reduction and leaves a residual risk of 3.1 x 10-7. About 21,000 pounds (9,545 kg) of VOCs would be extracted within the approximately 4 billion cubic feet of contaminated groundwater.

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Hence, all the alternatives achieve essentially 100 percent toxicity reduction. Alternatives 1 through 6 are comparable with respect to risk reduction and mass removal, and they leave a residual risk within EPA's acceptable risk range. The only significant difference between the alternatives is in the volume of contaminated groundwater to be contained and extracted. Mass removal and risk reduction can be achieved as well though Alternatives 1 and 4A as through Alternatives 2, 3, 4, 5, and 6, while containing less volume and requiring less cost. Thus,

although all the alternatives provide equal long term effectiveness and permanence, Alternatives 1 and 4A provide the best cost-effectiveness. Cost will be discussed in Section H.7.

H.4 Reduction in Toxicity, Mobility, and Volume through Treatment

This comparison criterion applies to all alternatives. It focuses mainly on reduction of contaminant mass through treatment, Alternatives 1 through 6 would equally reduce the toxicity, mobility, and volume of contaminants through their treatment methods.

All the treatment processes are similar since spent carbon is commonly regenerated by desorbing the contaminants and oxidizing the resulting airborne gaseous compounds (possibly by thermal or catalytic oxidation processes). Hence, there is not a significant difference in the ultimate destruction of the contaminants; the difference is where it occurs.

In the cases of Alternatives 1, 2, 3, and 5, destruction of the contaminants from OU A takes place in the catalytic oxidation unit of the east side treatment plant. In the cases of Alternatives 4, 4A, and 6, destruction of the contaminants from OU A takes place at the carbon regeneration facility, which potentially could be outside California for all alternatives, including the No-Action Alternative, destruction of contaminants from OUs B, C, and D take place in the thermal oxidation unit of the existing west side treatment plant. Given that the ultimate destruction of the contaminants is similar for the three treatment options, the alternatives are considered equivalent with respect to reduction of toxicity, mobility, and volume by treatment.

H.5 Short-Term Effectiveness

This comparison criterion applies to all alternatives. Alternatives will be evaluated with respect to effects on human health and the environment during the installation and operation phases of the remedial action, until the remedial response objectives are met.

The No-Action Alternative is acceptable in that the operation of the existing groundwater treatment plant does not pose a threat to workers, the community, or the environment. As a Basewide Ground water OU remedial action, it is unacceptable because it does not address various source or uncontained contaminated areas and effectively would require an infinite time to clean up these areas. Workers involved with construction of facilities for Alternatives 1 through 6 would not be exposed to any greater risks than normally encountered during installation activities. Installation activities would not be expected to expose the public to increased risks.

Short-term health risks during implementation could be associated with emissions of acid and oxidant gases from CatOx offgas treatment in Alternatives 1, 2, 3, and 5. Mitigation of these impacts could involve selection of a remedial action alternative that does not involve the use of CatOx, such as in Alternatives 4, 4A, and 6, installing emission controls for acid and oxidant gases, or siting the facility so that air quality impacts fall on uninhabited locations.

The time needed to reach the protection varies with each target volume and is primarily a function of water flow rate, and initial and final contaminant concentration. Initial concentration and final concentration vary with the target volumes and the specific location of contaminants within a target volume. Figure 25 estimates the time required to reach the target concentration, and the effect of initial concentration and final concentrations by target volume for TCE.

Figure 25 has been developed assuming that the NAPLs are isolated within the target volumes. Times to cleanup increase as initial concentrations increase, indicating that hot spot areas will take longer than containment areas. On the other dimension, Figure 25 shows that cleanup times will be longer if the final concentration is lower, as is the case with the background target volume versus the 10-6 cancer risk, versus the MCL. It would take approximately 35 to 100 years to extract groundwater to MCLs in Alternatives 1 and 4A, 65 to 120 years to extract groundwater to 10-6 risk levels in Alternatives 2, 4, 5, and 6, and 100 to 160 years to extract groundwater to background level in Alternative 3. Hence, Alternatives 1 and 4A would achieve protectiveness first. If the DNAPLs were not isolated, the remediation time could be hundreds of years.

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H.6 Implementability

This comparison criterion applies to all alternatives. It compares alternatives on the basis of technical and administrative feasibility, as well as availability of materials and services required for implementation.

Alternatives I through 6 are similar in their technical feasibility. All standard treatment technologies identified for the alternatives are proven in applications at similar hazardous waste sites. Engineering principles and calculations can be applied to design and specify the types of equipment in the options chosen with relatively high accuracy. In addition, numerous vendors are available for each component, providing excellent availability of most services and materials.

The treatment option in Alternative 6 would be easiest to implement. LGAC does not emit offgas and therefore does not require permits. Alternatives 4 and 4A would be next easiest to implement because, although they would be subject to substantive requirements of air discharge permits, VGAC does not emit NOx and would not require offsets or credit purchases. The treatment options in Alternatives 1, 2, 3, and 5 would be subject to substantive requirements of air discharge permits and, possibly, would require NOx offsets or NOx credit purchases.

Injection, the end-use option in Alternatives 1, 2, 3, 4, 4A, and 6, would be easier to implement from an administrative standpoint than providing water to the water districts, the end-use option in Alternative 5.

Table 14 summarizes the implementability of each alternative, including the No-Action Alternative.

H.7 Cost

This comparison criterion applies to all alternatives. It compares alternatives on the basis of capital costs, both direct and indirect, as well as O&M costs. In addition, the time value of money is considered in analyzing and comparing alternatives.

The cost of the alternatives is directly related to the size of the target volume to be contained. Target volume size affects the number of extraction wells, the number of wellhead treatment units, the length of conveyance pipelines, the size of the treatment units, annual operations and maintenance costs, and ultimately the length of operation.

Table 15 presents capital costs, O&M costs, net present value, total cash outlay, and cash outlay after 11 years for each of the alternatives. These costs were performed for an analysis period of 20 years, using an interest rate of 5 percent.

Table 14
Implementability

Factor	Alternatives							
	No Action	1	2	3	4	4A	5	6
Containment Option								
Technically Feasible	N/A	√	√	√	√	√	√	
Treatment Option								
Technically Feasible	N/A	√	√	√	√	√	√	
Vendors, Installation Contractors, and Operation Resources Locally Available	N/A	√	√	√	√	√		√	√
Does Not Require Air Discharge Permit	N/A							√
Does Not Require NOx Offsets or Credit Purchase	N/A				√		√	√
End-Use Option								
Technically Feasible	N/A	√	√	√	√	√	√	

Table 15
Cost Summary ($)
McClellan AFB Groundwater Operable Unit

Cost Indicator	Alternative 1	2	3	4	4A	5	6
Capital Cost	23,293,518	27,221,668	35,620,337	26,638,666	23,257,873	26,696,499	26,536,860
O&M Cost-first 5 years	2,208,000	2,610,000	3,335,000	2,553,000	2,208,000	2,912,000	2,553,000
O&M Cost-years 6 through 19	2,845,000	3,558,000	3,993,000	3,656,000	3,144,000	3,977,000	4,699,000
Net Present Valuea	54,900,000	66,100,000	81,000,000	66,000,000	57,200,000	70,100,000	74,000,000
Total Cash Outlaya	74,200,000	90,100,000	108,200,000	90,600,000	78,300,000	96,900,000	105,100,000
Cash Outlay after 11 yearsa	22,800,000	28,500,000	31,900,000	29,200,000	25,200,000	31,800,000	37,600,000

aAssumptions:
Interest Rate = 5 percent
Analysis Period = 20 years

Alternatives 1 and 4A are the least costly alternatives because they contain the MCL target volume. Alternatives 2, 4, 5, and 6 are more costly because they contain the 10 risk target volume. Alternative 3 is the most costly because it contains the background target volume.

Because the time to achieve cleanup is considerably shorter for containing the MCL target volume than the risk or the background target volumes, as discussed in Section H.5, the total costs of Alternatives 1 and 4A would be much lower than the other alternatives.

The difference between Alternatives 1 and 4A is the treatment system in the prospective new east side treatment plant. For conditions at McClellan AFB, operating a catalytic oxidation system is less expensive than operating a granular activated carbon system. Hence, of these two alternatives, Alternative 1 is the least costly.

H.8 State Acceptance

The FS and the Proposed Plan were reviewed by the U.S. EPA, Cal-EPA/DTSC, and the RWQCB. The proposed remedy in those documents recommended Alternative 4: containment of the 10-6 risk target volume, treatment with AS/VGAC/LGAC, and an end-use option that included discharge to McClellan AFB's greywater system, discharge to Magpie Creek, and injection.

Since then, however, McClellan AFB has selected containment of the MCL target volume as the containment option, rather than containment of 10-4 risk target volume. In a letter dated September 27, 1994, the RWQCB acknowledged that in light of the fact that this is an Interim ROD and that cleanup criteria are not being established at this time, the interim remedial action does not need to comply with ARARs regarding final cleanup values. Also, the RWQCB does not object to reducing the volume of water captured to that which contains contaminants exceeding MCLs, but only because this is an Interim ROD. The RWQCB cautioned that, when the Final ROD establishes final cleanup standards for McClellan AFB, the final cleanup level may be more restrictive than MCLs.

ARARs affecting final cleanup standards will be evaluated in 2003, the proposed date of the Final ROD. The Final ROD will establish final cleanup standards for McClellan AFB.

Hence, Alternative 4A was added to the list of alternatives in this Interim ROD. Alternative 4A includes the same treatment and end-use options as Alternative 4, but selects containment of the MCL target volume instead of containment of the 10-6 risk target volume. A more thorough discussion of this significant change is presented in Section K1.

In letters to McClellan AFB and the Department of Toxic Substances Control, dated December 6, 1993, April 18, 1994, October 28, 1994, and February 28, 1995, DHS/ODW stated its concerns regarding use of treated groundwater from McClellan AFB as a source for a domestic water supply. The State understands that McClellan AFB is continuing to evaluate use of the treated groundwater as a possible domestic water supply, and at a final end-use decision will be presented in the Final ROD.

H.9 Community Acceptance

The Proposed Plan was presented to the community in June 1994. A public comment period was held from July 6 to August 15, 1994. During the public comment period, two comment letters were received. A public meeting was held on July 20, 1994, during which approximately 30 comments were made and questions asked.

Of the two letters received, one inquired about compensation to the community that experienced property value declines as a result of offbase groundwater contamination. The second letter stated preference for containment to background levels.

During the public meeting, individuals from the local community made formal comments stating preference for containment of the background target volume as the containment option, over containment of the MCL and 10-6 risk target volumes. The community prefers containment to background levels because this option would leave the minimal amount of residual risk and would restore the aquifer to its conditions before Base activities began.

Also during the public meeting, one formal comment stated objection to sale of treated water to

water districts for domestic uses. The public is concerned about treatment plant malfunctions and the possibility that the local community could ingest contaminated groundwater that was not properly treated. The public stated preference for water being used in McClellan's greywater system, discharged into Magpie Creek, or injected into deeper aquifers, as in Alternatives 1, 2, 3, 4, and 6.

No formal comments were made regarding the treatment system.

Several individual questions were asked during the public meeting regarding topics such as surface runoff in Magpie Creek, sampling and decommissioning of municipal wells, and the future funding for McClellan AFB.

None of the comments received provided McClellan AFB with the technical justification to select an option that contained groundwater to 10-6 risk or background levels, over Alternative 4A, which contains groundwater to MCLs. McClellan AFB remains convinced that Alternative 4A is essentially as protective of human health and the environment as any of the options that would contain groundwater to 10-6 risk or background levels. McClellan AFB believes that the actual percent of risk reduction, remaining risk, and mass removal through containment of the three target volumes are identical. The only difference is the volume of contaminated groundwater to be contained and, hence, the substantial cost differences between containing the groundwater in the three different target volumes.

All community concerns and comments received during the public comment period are addressed in the Responsiveness Summary (Part III) in this Interim ROD.

I. Selected Remedy

I.1 Basis of Selection

The remedy was selected after performing the comparative analysis in Section H. The selected remedy includes Alternative 4A and a component of End-use Option 1. The selected remedy consists of the following actions:

- Containment: Alternative 4A calls for groundwater contaminated at levels greater than Maximum Contaminant Levels (MCLs) to be extracted at pumping rates that prevent its further migration. Containment to prevent offbase plume migration is the highest priority of this remedy, followed by containment of the hot spots and containment to prevent vertical downward migration. Eventually, all groundwater will be contained so that no water above MCLs will leave the Base boundaries. Groundwater extraction wells will also be located in areas with the highest contaminant concentrations (hot spots/sources). Aggressive pumping of these wells will rapidly reduce the total amount of groundwater contamination and its associated risk.

- Treatment: Alternative 4A calls for groundwater extracted on the west side of the Base to be treated at the existing groundwater treatment plant (GWTP). The GWTP removes the VOCs from the water by air stripping followed by granular activated carbon polishing. The air stripper offgas is treated by thermal oxidation. The extraction system may exceed GWTP capacity. An east side treatment plant will be constructed if necessary; it will use air stripping and granular activated carbon for water treatment and vapor-phase carbon filters for treating the air stripper offgas.

- End-Use: Alternative 4A calls for using as much treated water as possible in the Base's greywater system. Surplus water not used in the greywater conveyance system would be discharged into Magpie Creek and/or injected into the groundwater. The selected remedy may also include providing the treated water to neighboring water districts, which is a component of End-Use Option 1.

- The Air Force believes it is premature at this time to specify any one or any combination of end-uses for the treated water in this Interim ROD. The final decision on the end-use will be determined in the Final ROD, depending on the actual quantity of water that needs an end-use and further discussions with potential recipients of the treated water.

- All of the end-uses presented above were evaluated in the Feasibility Study. Each end-use option included using the existing greywater system to the fullest extent possible, which at the time the FS was performed was 200 gpm. McClellan AFB has proceeded to evaluate and repair the greywater system to increase its capacity and also has worked with industrial users onbase to identify other nonpotable uses for the treated groundwater. Several industrial uses are available, and it appears that continuous use of the treated groundwater at nearly 600 to 800 gpm is possible. At McClellan AFB, the greywater system is the nonpotable use system and could be used to provide treated groundwater to industrial users. The total flow that may require end-use is estimated to be greater than 1,000 gpm, but the actual quantity could be substantially higher once the full extent of contamination of the D Zone is identified.

- It is the Air Force's preference at this time to provide all the water to the greywater system for onbase industrial and nonpotable use. If the greywater system cannot be upgraded to receive the total quantity of water that will be extracted, then the Air Force will evaluate providing the water to neighboring water districts, discharging the water into Magpie Creek, injecting the treated water, and combinations of these options. Each of these options complies with ARARs. The Air Force will be seeking the end-use with the least cost and the fewest institutional obstacles. The cost and feasibility of each option are dependent on the flow rate, which will be determined during the course of the interim remedy. These options are discussed in detail in Section G.3.

A more detailed discussion of the elements of the Selected Remedy is presented in Section I.2. The remedy was selected for the following reasons:

- Although the least stringent of all the containment options, the level of protection to human health and the environment provided by the containment option in Alternative 4A meets MCL requirements for drinking water. The treatment and end-use components of Alternative 4A offer the same level of protection as the other alternatives.

- Alternative 4A meets all ARARs without the need to acquire NOx offsets or purchase NOx credits.

- Alternative 4A provides the same level of long-term effectiveness and permanence as the other alternatives, but requires the containment of less volume of groundwater. Therefore, groundwater extraction, treatment, and end-use costs are reduced significantly. Long-term effectiveness and permanence are measured by risk reduction, residual risk, and mass removal.

- The treatment option in Alternative 4A reduces toxicity, mobility, and volume to the same level as the treatment options in the other alternatives.

- Short-term risks as a result of the construction of Alternative 4A are the same as for the other alternatives. Alternative 4A will not cause short-term health risks due to emissions of acid and oxidant gases, as alternatives that use catalytic oxidation to treat air stripper emissions would.

- Alternative 4A is technically and administratively implementable. Some of the other alternatives are not.

- Of the seven alternatives, Alternative 4A is the second least costly. Costs presented in Table 16 for Alternative 4A assume that the end-use option would require four injection wells. If the greywater system and Magpie Creek have the capacity to receive all treatment plant discharge, injection will not occur and capital and O&M costs will be reduced. Likewise, if the treated water is provided to the water districts, capital and O&M costs are likely to be reduced.

- Alternative 4A received state and federal acceptance.

- The treatment and end-use options of Alternative 4A have met with community acceptance. A Fact Sheet documenting the selection of the containment option, containment of the MCL target volume, has been distributed to the community (see Section K.1 for a further discussion).

Table 16: Range of Costs for Alternative 4A

Cost Indicator	Alternative 4A Without Injection ($)	Alternative 4A With Injection ($)
Capital Cost	21,050,431	23,257,873
O&M Cost-first 5 years	2,208,000	2,208,000
O&M Cost-years 6 through 19	3,091,000	3,144,000
Net Present Valuea	54,600,000	57,200,000
Cash Outlay Valuea	75,400,000	78,300,000

aAssumptions:
Interest Rate = 5 percent
Analysis Period = 20 years

I.2 Elements of the Selected Remedy

The preferred remedy for the Groundwater OU is Alternative 4A. Providing treated water to neighboring water districts, as described in End-Use Option 1, is also being explored as an end-use for the treated water. The layout of the main components of the remedy is presented in Figure 26. This alternative consists of the following actions:

- Groundwater contaminated at levels above MCLs will be extracted at pumping rates that prevent its further migration.
- Groundwater extraction wells will also be located in areas with the highest contaminant concentrations (hot spots/sources).
- Operation of existing extraction systems in OU B, OU C, and OU D and the existing west side treatment plant will be continued.
- If necessary, extracted groundwater will be treated at a new east side treatment plant by air stripping followed by further polishing using liquid-phase granular activated with vapor-phase granular activated carbon filters.
- As much treated water as possible will be reused in the McClellan AFB greywater system. The remaining water will be discharged to Magpie Creek or injected into the groundwater beneath the Base. Preference will be to discharge the remaining water to Magpie Creek. McClellan AFB is continuing to explore with Cal-EPA, U.S. EPA, and surrounding communities how best to utilize the treated groundwater, including providing it to neighboring water districts.
- Effluent discharge limits and limits of quantitation for any new units that treat groundwater and discharge effluent to surface and/or groundwater are presented in Table 17. Inorganic discharge limits for injection of treated groundwater will be established after inorganic background concentrations are determined.
- Further characterization and evaluation will be conducted during design of the remedy: (1) determining appropriate locations for extraction wells and injections wells, (2) field testing of groundwater injection, (3) determining the need for removal of metals from extracted groundwater, (4) searching for existing wells that are at risk of spreading contaminated groundwater, (5) determining aquifer parameters through aquifer tests on new extraction wells, and (6) continuing to monitor water levels and water quality in monitoring wells.
- Treatment of the BW-18 wellhead will continue so long as BW-18 is in operation as a water supply well.
- Existing wells at risk of spreading contaminated groundwater will be sealed or destroyed. Contingency plans will be designed for the appropriate offbase wells (currently CW-132 and CW-155, but there could be additional wells threatened by OU A contamination). BW-18 will be properly decommissioned, and the water supply will be replaced. Other Base wells that may serve as conduits to contamination will also be properly decommissioned. This is an ongoing program.

The long-term data acquisition system, a telemetry system for gathering continuous data remotely, will be designed, if required.

The effectiveness of the Basewide and plume-specific extraction well fields will be evaluated. Operations and maintenance plans will be prepared.

Phased design and construction efforts will be staged in a sequence that allows the contamination problems to be addressed first and promotes efficient integration with existing groundwater extraction and treatment system.

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Table 17

GWTP Effluent Limitations and Limits of Quantitation
McClellan AFB-Groundwater OU

Contaminant	Limit of Quantitationa (µg/l)	Limit of Quantitation (µg/l)	Effluent Limitc (µg/l)
Benzene	0.12	0.063	0.5
Carbon Tetrachloride	0.20	--	0.5
Chlorobenzene	0.22	0.046	0.5
Chloroethane	0.50	--	0.5
Chloroform	0.13	0.053	0.5
1,2-Dichlorobenzene	0.09	0.252	0.5
1,3 Dichlorobenzene	0.19	0.179	0.5
1,4-Dichlorobenzene	0.19	0.372	0.5
1,1-Dichloroethane	0.12	0.067	0.5
1,2-Dichloroethane	0.08	0.080	0.5
1,1-Dichloroethylene	0.18	0.050	0.5
t-1,2-Dichloroethylene	0.01	0.043	0.5
Dichloromethane	0.10	--	0.5
Ethylbenzene	0.18	0.035	0.5
1,1,2,2-Tetrachloroethane	0.09	--	0.5
Tetrachloroethylene	0.25	0.076	0.5
Toluene	0.26	0.045	0.5
1,1,1-Trichloroethane	0.17	–	0.5
Trichloroethylene	0.37	0.103	0.5
Trichlorofluoromethane	0.46	--	0.5
Vinyl Chloride	0.25	–	0.5
Xylenes	0.11	0.061	0.5
Total Petroleum Hydrocarbons	--	--	50.0
pH (pH Units)	–	--	6.5 to 8.5

Notes: Receiving waters limitations and effluent limits for SVOC as specified in the discharge requirements for the existing GWTP will be met.

a Quantitation limits currently achieved by McClellan AFB using EPA Methods 502.1 and 503.1 for GWTP.
b Reporting limits currently achieved by McClellan AFB using Methods 8010 and 8020, GSAP results.
c Daily maximum value.

I.3 Priorities for Extent of Contamination Investigation and Containment

All the elements described in Section 1.2 are of high priority because they are either predecessors to achieving containment, or predecessors to major design decisions or activities that could alleviate imminent threats.

At this time, the extent of contamination is not completely defined. Because data gaps exist, as presented in Section E.5, the extent of contamination will be investigated further. In addition, containment of the groundwater plume will occur concurrently with further investigative efforts.

The remedy will be implemented in a phased approach because of the need to resolve uncertainties, the magnitude of the potential remedy, and resource constraints. Hence, areas requiring more investigation and areas where containment would be implemented have been prioritized. These priorities are summarized in Table 18.

Table 18
Investigation and Containment Priorities

Portion of Containment Plume	Investigation Priority		Containment Priority	
	Highest	Other	Highest	Other
OUs B and C deep plume	X		X	
OU B offbase plume moving south	X		X	
OU A southern plume	X		X	
OU A eastern offbase plume	X		X	
OUs A, B, and C hot spots		X	X	
OU G and H plume	X			X
OU A onbase western plume (along runway)		X		X
OU C onbase eastern plume (along runway)		X		X
OUs E and F contamination		X		X
Low concentration offbase plume west of OU C		X		X
Further remedial action at OU D plume		X		X

The phasing planned for the investigation of extent of contamination and the containment of groundwater is discussed in Section I.4, Implementation Schedule, and shown in Figure 27.

The OU A and B offbase plumes are high priorities because they ane potential threats to offbase water users. The deep plume beneath OUs B and C is a high priority because the contamination is in the more permeable materials subject to pumpage by water users. The hot spots are a high priority because the isolation of the vast majority of contaminant mass can be achieved by containment of the hot spots.

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Onbase contamination is a lower priority because threat to the public or onbase workers does not exist. The offbase contamination west of OU C is a lower priority because the Air Force has replaced individual water wells with potable supply, thereby removing the threat to the public. In addition, the concentrations are low and much farther from water supply wells than the OU B plume.

I.4 Implementation Schedule

The preferred alternative will be implemented in three phases:

- Phase 1 will reduce data gaps and begin containment of the high-priority areas.
- Phase 2 will further define the plume boundaries, complete containment of the high priority areas, and begin containment of lower-priority areas.
- Phase 3, if necessary, will complete the containment of the contaminated groundwater.
- When groundwater extraction rates and concentrations are sufficiently defined, construction will begin on the major water pipelines and, if needed, the east side treatment plant. Each phase is estimated to take up to 2 years to complete.

J. Statutory Determinations

The applicability and compliance of the following statutory determinations are discussed in this section:

- Protectiveness
- Applicable or Relevant and Appropriate Requirements
- Cost-Effectiveness
- Use of Permanent Solutions, Alternative Treatment, or Resource Recovery Technologies
- Preference for Treatment as a Principle Element

J.1 Protectiveness

This interim action is protective of human health and the environment in the short term and is intended to provide adequate protection until the Final Basewide ROD is signed. Protection is achieved at the Base and in the aquifers underlying the Base in the following ways:

- Initial protection to human health will be achieved by preventing offbase contaminant migration to private and municipal production wells.
- Containment of groundwater within the MCL target volume by extraction will protect humans from exposure to contamination above acceptable risk levels.
- Extraction of contaminated groundwater from Monitoring Zones A, B, and C will halt the downward migration of contaminants and protect the deeper aquifers from

degradation.

- Decommissioning Base wells that are believed to be vertical migration conduits, such as BW-18, will protect the deeper aquifers from contamination migration from the shallower aquifers. BW-18 also increases the migration rate of contaminants from the A and B Zones into the lower zones.

- Treatment of VOC-contaminated groundwater to discharge limits prior to discharge protects the environment from degradation. Discharge limits are discussed in Section I.2.

- As much treated water as possible will be reused in the Base greywater system. Treatment of VOC-contaminated groundwater to discharge limits protects humans from inhalation exposure.

- Granular activated carbon used in the standard treatment technology will be regenerated at an offbase facility, removing any local health risks from the extracted VOCs.

J.2 Applicable or Relevant and Appropriate Requirements

The selected remedy complies with federal and state ARARs for this limited scope action.

J.3 Cost-Effectiveness

The remedy is cost-effective because adequate protection is achieved for the estimated cost of performance. The selected remedy is to control and treat groundwater within the MCL target volume. The analysis contained in the FS and summarized in Section I, Selected Remedy, of this Interim ROD demonstrates that additional remedial action and cost associated with containing and treating the water within the 10-6 risk volume or the background target volume will not achieve a significantly greater reduction in risk. It would result, however, in a dramatically higher cost because greater groundwater volumes would be extracted and treated.

J.4 Use of Permanent Solutions, Alternative Treatment, or Resource Recovery Technologies

Although this interim action is not intended to fully address the statutory mandate for permanence and treatment, this interim action of containment of the MCL target volume and treatment of groundwater to less than discharge limits uses treatment and thus is in furtherance of that statutory mandate. The selected remedy represents the best balance of tradeoffs among alternatives with respect to pertinent criteria, given the limited scope of the action. Subsequent actions are planned to address fully the threats posed by the conditions in this OU.

J.5 Preference for Treatment as a Principle Element

Because this action does not constitute the final remedy of the Groundwater OU, the statutory preference for remedies that employ treatment and that reduce toxicity, mobility, or volume as a principal element, although partially addressed in this remedy, will be addressed by the final response action. Because this remedy will result in hazardous substances remaining onsite above health-based levels, a review will be conducted to provide adequate protection of human health and the environment within 5 years after commencement of the remedial action. Because this is an interim action ROD, review of this site and this remedy will be ongoing as remedial alternatives for the final remedy are developed.

K. Documentation of Significant Changes

The Proposed Plan for the Groundwater OU was released for public comment from July 6 to August 15, 1994. The Proposed Plan identified Alternative 4, which consists of the following components:

- Groundwater contaminated at levels greater than 10-6 cancer risk would be extracted at pumping rates to prevent its further migration. Aggressive pumping would also occur at areas with highest contaminant concentrations.

- Extracted groundwater would be treated by air stripping followed by further cleaning using granular activated carbon filters until discharge limits are met.

- Up to 200 gpm of treated water would be reused in the McClellan AFB greywater system. The remaining water would be discharged to Magpie Creek and/or injected into the groundwater beneath McClellan AFB.

The containment and end-use components of the selected remedy presented in this Interim ROD differ from those of the selected alternative presented in the Proposed Plan. The differences and the reasons for these significant changes are discussed in the following paragraphs.

K.1 Changes to the Containment Component of the Selected Remedy

The preferred containment component of the selected remedy, as presented in the Proposed Plan, has changed from containment of groundwater at contaminant levels greater than 10-6 cancer risk. During the public comment period for the Proposed Plan, however, McClellan AFB, in consultation with the agencies, decided to choose containment of the MCL target volume as the containment component of the selected remedy. Containment of the MCL target volume was selected over containment of the 10-6 cancer risk target volume for the following reasons:

- Risks remaining to the public are virtually the same after containing the groundwater contamination either to the MCL target volume or to the 10-6 risk target volume.

- Use of the MCL target volume instead of the risk target volume reduces the amount of groundwater to be pumped. The number of wells and pipelines and the treatment system capacity are therefore also reduced, resulting in lower capital costs of as much as $3.3 million for the interim remedy.

- Time to achieve containment is reduced because the volume of aquifer to be contained is reduced, the number of extraction wells is reduced, and the implementation schedule could be shortened by as many as 3 years.

Alternative 4A was included in this Interim ROD to evaluate containment and extraction of the MCL target volume as the containment option, keeping the same treatment and end-use as Alternative 4. The decision to contain the MCL target volume was made in conjunction with the U.S. Environmental Protection Agency and Cal-EPA (DTSC and RWQCB).

Table 19 is a comparison of the decision factors-volume, cost, time, and risk-for contaminant of the MCL and the risk target volumes. This change in remedy was summarized in a Fact Sheet that was distributed to the public in December 1994. A new public comment period was not held because the MCL containment option was thoroughly examined in the FS and presented in the Proposed Plan. The combination of the MCL containment option with the other two preferred options to form the new alternative is a logical outgrowth of the final review of the previously released documents, response to comments, and preparation of this Interim ROD.

K.2 Changes to the End-Use Component of the Selected Remedy

The two end-use options presented in the Proposed Plan have been modified. In the Proposed Plan, both end-use options include reusing the first 200 gpm of treated groundwater in McClellan AFB's greywater system. In this Interim ROD, a limit has not been placed on the quantity of treated water to be reused in the greywater system.

During the FS, it was determined that McClellan AFB's greywater system had a need for only 200 gpm. Since the Proposed Plan, investigations and testing of the greywater system have suggested that it may be able to reuse significantly more than 200 gpm of treated water. Hence, under both end-use options, it has been stated in this Interim ROD that as much treated groundwater as possible would be reused in the greywater system. The remaining treated water would be provided to the water districts, as in End-use Option 1, or discharged to Magpie Pie Creek and/or injected, as in End-Use Option 2.

Table 19
Comparison of Decision Factors for the MCL and Risk Target Volumes

Decision Factors	Containment of the MCL Target Volume (Alternative 4A)	Containment of the Risk Target Volume (Alternative 4)	Result of Changing to MCL Target Volume
Volume of Aquifer (including soil matrix and pore space)	1.24 billion ft3	2.06 billion ft3	Reduces volume of aquifer to be contained by 0.82 billion ft3 (291 billion gallons)
Cost of the Remedy	Capital: $23.3 million	Capital: $26.6 million	Saves $3.3 million
	Net Present Valuea: $57.2 million	Net Present Valuea: $66.0 million	Saves $8.8 million
Time to Implement Containment	4 years	7 years	Saves up to 3 years
Remaining Risk after Containment	3.1 x 10-6 (a 3-in-1,000,000 additional risk)	1 x 10-6 (a 1-in-1,000,000 additional risk)	Remaining risk will increase slightly but still falls within the acceptable National Contingency Plan rangeb

aNet Present Value assumes an interest rate of 5 percent and an analysis period of 20 years.
bThe National Contingency Plan acceptable risk range that remedial actions are expected to achieve is 10-4 to 10-6, or 1 in 10,000 to 1 in 1,000,000.

Part III: Responsiveness Summary

A. Introduction

This section presents information about community preferences and public concerns regarding the remedial alternatives and the preferred alternative for the groundwater beneath McClellan AFB, referred to as the groundwater OU site. Opportunities for community involvement in the groundwater remedial action at the Groundwater OU site consisted of a public comment period on the site-related documents held from July 6 to August 15, 1994. On July 20, 1994, a public meeting was held at Bell Avenue School in Rio Linda to present the McClellan AFB proposed cleanup plan for the site contamination. The meeting format consisted of a formal presentation by McClellan AFB and a formal question and answer period. The proceedings of the meeting were recorded by a court reporter and the transcript became part of the Administrative Record for the Groundwater OU site. Two formal comments were also received in writing during the public comment period. Approximately 30 oral comments were made or questions asked during the public meeting. Responses to oral comments that were not answered during the public meeting and responses to the two written comments are presented below. The transcript from the public meeting is part of the Administrative Record.

After the public comment period, McClellan AFB in December 1994 distributed to the public a Fact Sheet that explained the change in the containment goal (from 10-6 risk to MCLs). As explained in greater detail in Section K.1, Changes to the Contaminant Component of the Selected Remedy, a new public comment period was not held because the MCL containment option was thoroughly examined in the FS and presented in the Proposed Plan.

Historic and current concerns of the public primarily have focused on the potential effects of contaminated groundwater on long-term health and residential property values. The community has also been concerned with aesthetic effects on and contamination of Magpie Creek.

B. Oral Comments from the Public Meeting

Comment: "...I'm concerned that the stuff off-base that's originating from McClellan Air Force Base...that it would be cleaned up. And so in fact I'd like it to be cleaned up to the background levels instead of 10 to the minus 6 because I'd like to see the water clean like it was before all this began."

"...I would like to state for the record that I prefer the background levels rather than 10 to the minus 6."

"...Why not have natural background levels as the preferred cleanup alternative and aim for a higher and achievable standard, which I favor?"

Response: It has been shown in this Interim ROD that containing and extracting the groundwater to background levels would result in only incremental risk reductions in comparison to containing and extracting groundwater MCLs, yet would require the pumpage of significantly higher quantities of water. This would result in significantly higher costs. In addition, the mass of VOCs that would be removed is almost equal in the background, risk, and MCL target volumes. The background target volume is more than three times larger than the MCL target volume and nearly two times larger than the risk target volume.

Comment: "...what's the cost per gallon for some of these processes?"

Response: At this time it is not possible to predict the gallons that would need to be extracted for each of the alternatives or the absolute costs for the duration of operations.,

Comment: "...And then the emissions from the air stripper is [sic] just vented into the air, or do you collect that?"

Response: The offgas emissions from the air stripper are passed though a vapor phase granular activated carbon unit to collect the VOCs that were removed from the groundwater during the air stripping process. Offgas emissions from the air stripper are not vented into the air.

Comment: "I don't think it's a good idea to use water [for domestic uses] that's contaminated and being drawn up and cleaned just in case there is a slight remote possibility... that for some reason the equipment will go... away... and.. people could be possibly drinking contaminated water. I don't think that this would ever happen, but just the same, feel safer with it going to industrial uses such as cooling towers, or getting re-circulated through the shops or being injected into the underground aquifer or discharged to Magpie Creek. These are alternatives that I think are viable, and we don't have to worry about somebody drinking contaminated water. Even if he chance is slight and minute, it's still slight and minute

Response: As mentioned in Part II of this document, DHS/ODW also has concerns about sale of treated water to the water districts. That was the primary reason End-Use Option 1, providing to the water districts, was not selected for the preferred alternative.

C. Written Comments

Comment: "... has there been any consideration given to compensation or the purchase of affected properties by the Air Force?"

Response: Compensation to property owners is not part of the groundwater remedial action.

Comment: "...We believe the cleanup and containment of contamination in the groundwater on and around McClellan AFB should be to background levels not to risk levels."

Response: As stated previously, it has been shown in this Interim ROD that containing and extracting the groundwater to background levels would result in only incremental risk reductions in comparison to containing and extracting groundwater to MCLs, yet would require the pumpage of significantly higher quantities of water. This would result in higher costs. In addition, the mass of VOCs that would be removed is almost equal in the background, risk, and MCL target volumes. The background target volume is more than three times larger than the MCL target volume and nearly two times larger than the risk target volume.

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